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KEPPEL STREET,
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ROYAL COMMISSION ON TUBERCULOSIS.

REPORT

OF THE

ROYAL COMMISSION

APPOINTED TO

INQUIRE INTO THE EFFECT OF FOOD DERIVED FROM TUBERCULOUS ANIMALS ON HUMAN HEALTH.

PART II.

LIST OF WITNESSES, MINUTES OF EVIDENCE, AND INDEX.

PART III.

APPENDIX. SPECIAL INQUIRIES.

LONDON:
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1895.

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ROYAL COMMISSION ON TUBERCULOSIS.

PART II.

LIST OF WITNESSES, MINUTES OF EVIDENCE, AND INDEX.

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MINUTES OF EVIDENCE

TAKEN BEFORE THE

ROYAL COMMISSION

APPOINTED BY ROYAL WARRANT, 21ST JULY 1890,

To Inquire and Report what is the effect, if any, of Food derived from Tuberculous Animals on Human Health; and, if prejudicial, what are the Circumstances and Conditions with regard to the Tuberculosis in the Animal which produce that effect upon Man.

FOURTH MEETING.

No. 7, Whitehall Place, S.W., Friday, 10th October 1890.

PRESENT:

THE RIGHT HON. THE LORD BASING PRESIDING.

Professor G. T. BROWN, C.B.
Dr. G. BUCHANAN, F.R.S.
Dr. J. F. PAYNE.
Professor J. B. SANDERSON, F.R.S.

Mr. LEOPOLD HUDSON, *Secretary*.

Dr. J. Dreschfeld.
10 Oct. 1890.

Dr. JULIUS DRESCHFELD, Doctor of Medicine, Fellow of the Royal College of Physicians, London; Professor of Pathology, Victoria University; and Physician to the Manchester Royal Infirmary, called and examined.

1. (*Chairman.*) You are Professor of Pathology, I believe, in the Victoria University at Manchester?—Yes, my Lord.

2. And you have paid attention, partly on your own account, and partly at the instance of others, to the question of tuberculosis?—Yes.

3. Both as it affects the lower animals, and also so far as it may be connected with the disease which we know as phthisis in man?—Yes.

4. The Commission has already a great deal of matter before it in connexion with the experiments which have been made by other people and the opinions which have been given by other persons—evidence taken by a departmental committee constituted by the Board of Agriculture. We are anxious not to repeat in the Blue Book, which it will be our fate to produce, facts that are already before the public in other ways and by other means. What we should like to get from you are the results of your investigations as far as they apply to your own personal experience in connexion with this subject. Perhaps I had better quote to you a passage from the Royal Commission itself, which intimates to us what our duties are to be. We are not to say whether butchers are to have a grievance or whether animals are to be slaughtered which are comprised within the limits of a contract. We have "to inquire and report what "is the effect, if any, of food derived from tuberculous "animals on human health; and, if prejudicial, what "are the circumstances and conditions with regard to "tuberculosis in the animal which produce that effect "upon man." Now, if you will endeavour to state the result of your experience in the cases which you have investigated, as concisely as you can, with a view of enabling us to perform this duty we shall be obliged to you. We are aware that you are a great authority upon the subject?—I do not think it is necessary that I should enter into full details as to the series of experiments which I have made in order to show the effect of eating animals suffering from tuberculosis, but I may say that a large number of experiments have been made in France and Germany.

5. Have you conducted many experiments personally?—Yes, with the meat of animals which have been confiscated or condemned.

6. I presume that you mean confiscated in your own markets?—Yes, condemned by the inspector; some of it meat which has been sent into the market from various districts. I have experimented with 10 such specimens, and as for the animals experimented upon, I made use of rabbits.

7. Are you now speaking of experiments which you have conducted in respect of animals slaughtered for human consumption?—Yes; animals which have been confiscated because it was believed that the meat was bad and unfit for human consumption.

8. Will you divide your experiments into two groups, those cases in which the meat was taken from animals whose lungs were apparently healthy, and those in which the lungs were obviously diseased?—I may say that in all these cases the lungs were diseased. I made about 20 experiments.

9. Do I understand you to limit your experience to these 20 cases?—Not 20 cases. There were only 10 cases, but 20 experiments were made.

10. And the lungs were found to be diseased in every case?—Yes, in all the cases.

11. How did you connect the diseased lungs, which you must have afterwards seen, with the meat,

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J. Dreschfeld.
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apparently wholesome, which was sent to the market for sale ?—The moment the inspector condemned the animal the meat and also parts of the diseased organs were sent to me to report upon.

12. Then the animals were condemned by the inspector in the slaughter-house ?—Yes.

13. And in all cases the lungs and intestines showed symptoms of disease ?—In some the lungs and pleuræ only. I simply had a report from the inspector that the meat had been condemned.

14. Now go on in your own way, and tell us what the result of your experiments was ?—In four, I think, of the 10 samples the meat was bad ; the fibres were flabby, and there was an absence of fat. The badness of the meat was so apparent that it would be at once condemned by any inspector. Inoculation experiments with the meat in these cases resulted in the development of tuberculosis in the course of three weeks.

15. You say that the meat in these four cases was flabby and bad ; do you mean that there were perceptible tubercles in it ?—There were no tubercles in the meat in any of the cases.

16. In that case it was meat which, under no circumstances, under the Public Health Act, should be exposed for sale ?—No doubt any inspector would have condemned it.

17. Quite irrespective of its having tubercles that were perceptible ?—Yes, that was so. It was flabby, devoid of fat, and unfit for human food.

18. Of course that is so flagrant a case that it hardly comes within the scope of our inquiry, because under no circumstances could such meat have been exposed for sale without danger to the public who might consume it ?—That I do not know. I do not know how far it would be allowed to pass or not. At any rate, the inspector condemned it, and the disease in it was so marked that it would be apparent to anybody.

19. These remarks apply to four of the cases upon which you experimented ?—Yes, out of 10. In two of the other cases the meat looked fairly well, and in one of them especially so. In the fifth, though the meat looked well, the animal from which it was derived showed extensive tuberculosis, and the rabbit inoculated with the meat showed tuberculosis some time after inoculation.

20. What do you mean by the fifth animal ?—In the fifth case the meat looked fairly healthy, but there was tuberculosis of the internal organs, and the rabbit which was inoculated with it showed tuberculosis two months afterwards. In the case of the first four samples, where the meat was manifestly bad, tuberculosis was developed in the course of three weeks after inoculation, but in the fifth case inoculation did not develop tuberculosis for two or three months.

(*Professor Burdon-Sanderson.*) Perhaps it would be as well to have the state of the meat first.

21. (*Chairman.*) Yes, I think we are getting into a little confusion. (*To witness.*) You say that in four cases the meat was flabby and looked unwholesome ?—Yes.

22. That was quite apart from any development of tuberculosis ?—Yes.

23. You say that in two other cases the meat looked healthy and in one of them particularly healthy ?—One of the two samples looked healthier than the other.

24. And then what happened ?—In one of the two cases tuberculosis developed two months afterwards in the rabbit which had been inoculated. In four—the remaining four of the ten cases—though the lungs were diseased, the inoculation from the meat gave negative results.

25. (*Prof. Burdon-Sanderson.*) In the comparatively healthy one, or in the very healthy one ?—In the one that was very healthy tuberculosis was not developed until 2½ months after inoculation, which tends to show that the healthier the animal the longer it takes to develop tuberculosis.

26. (*Chairman.*) Was the tuberculosis apparent in the flesh in that case ?—No, nor was it in either. It is very rarely indeed that that is found to be the case. In the four cases in which the meat was condemned and was evidently bad, tuberculosis had formed, and was far advanced in the animals from which the meat was derived.

27. Then I understand you to say that in the four cases in which the meat was bad and condemned by the inspector, not only were tubercles apparent in the viscera but in the flesh also ?—Not in the flesh.

28. In the two other cases the flesh appeared to be quite healthy, but tuberculosis was developed in the animals inoculated with it ?—Just so.

29. What was the result of the two experiments ?—The development after inoculation was much more rapid in the one case than in the other.

30. Although the experiment in each case was the same ?—Yes, it was practically the same experiment in every case.

31. Did you try the same experiment in the cases in which the meat looked bad ?—Yes, it was the same in every one.

32. Did the inoculation in the case of the bad meat convey tuberculosis ?—Yes, within the first three weeks after inoculation, and there is no doubt that the disease might have been conveyed by these animals. I have a detailed account of all the experiments at home.

33. I understand you to say that the difference between the two classes of cases was this, that in the four bad cases tuberculosis appeared in three weeks after inoculation in the animals inoculated, whereas in the cases where the meat looked healthy it took two months ?—Yes, in some of the experiments made by Dr. Böllinger no practical result at all was obtained. The same thing has occurred in some of the French experiments.

34. Does it not rather result from these limited experiments that you might leave the thing to take its natural course, and say that if the meat looks healthy it is healthy ?—Yes, that is so, generally speaking, in my opinion.

35. And you quote other experiments in support of this view, as far as it goes ?—Yes, but I wish to point out that in some of the experiments I made the meat looked healthy, and yet there was tuberculosis.

36. How were your experiments conducted ?—Somewhat differently from those of Dr. Böllinger. I selected my samples from different parts of the meat upon which I experimented.

37. Were the animals experimented upon by inoculation ?—Yes, by inserting portions of the meat into the abdominal cavity of the animal experimented upon.

38. Would a rabbit swallow flesh like that experimented with ?—No.

39. Dogs being carnivorous animals would ?—Yes. I may say that with the meat which I got from the butchers—the flesh of the dead animals—I experimented upon two dogs. In the one case the meat was boiled and in the other it was raw. In neither case was any effect produced. Both dogs are alive now and very well.

40. The insertion of the polluted stuff into a dog's stomach in that way had no prejudicial effect ?—No.

41. But in other cases, by other means, it is capable of producing serious results ?—Most undoubtedly.

42. (*Dr. Buchanan.*) You do not mean the stomach, but the peritoneum ?—Yes.

43. (*Chairman.*) A rabbit will not voluntarily eat flesh ?—No.

44. You have quoted 10 cases in which you tried experiments ?—Yes.

45. Are they recent cases ?—Yes, they have all been made within the last 12 months.

46. Previously to that had you experimented or only philosophised ?—I had not experimented in regard to tuberculosis.

47. Of course we know that you have a great reputation. Do you wish us to understand that your deliberate judgment formed upon the experiments you have made induces you to believe that *primâ facie* when healthy loins of beef, or legs of beef, or whatever the

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parts may be, are exposed in the butchers' shops, and no suspicion is aroused in regard to their condition, they may be consumed without danger, notwithstanding the fact that if they were subjected to experiment the existence of tuberculosis might be discovered?—What I say is that tuberculosis may be found in the lungs, the pleura, the liver, or in the glands of the abdomen, despite the healthy appearance of the animal, and in such a case it ought to be condemned as food.

48. But you must go into the slaughter-house to discover that?—Certainly.

49. Suppose you do not go to the slaughter-house, but only to the butcher's shop?—In that case the fact might not be ascertained.

50. If the tubercles are not perceptible to the eye, do you go so far as to say that the flesh of the animal is fit for food?—No, I would not go as far as that. There may be tuberculosis in the interior of the animal that would condemn it for food, and yet the meat would look healthy and good.

51. May I put this question: Is it your judgment that if you go to a butcher's shop and buy meat which appears to be in a perfectly satisfactory condition it does not matter what the animal died of, provided the meat looks healthy in itself?—No, I do not say that.

52. That is not your opinion?—No, it certainly is not.

53. Then what is the use of these experiments? They might go on for ever, and you might have before you meat which appeared to be good, and with which you could find no fault, although tuberculosis existed in the lungs and liver?—In such a case the probability is that the animal would not be very far advanced in tuberculosis, and yet the experiments would show that the disease was there.

54. What would you propose to do in such a case, where the matter is still open to scientific investigation?—I do not see that anything further can be done than to provide that the animal should be inspected.

55. Would you provide that no animal should be sold for consumption the slaughtering of which had not been watched by some skilled person?—Yes, if you are to prevent the spread of disease you must prevent diseased meat from going into the market.

56. Would a skilled person be justified, if he saw that the lungs of an animal were diseased, in allowing the meat of that animal to go into the market, however good it might appear to be?—That would be for the inspector to decide.

57. I thought we got an opinion from you just now that where meat shows no symptom of disease of any sort or kind it may be eaten?—You must have misunderstood me. I did not say that. I think my experiments show the contrary.

58. I certainly thought that you adopted that view, and laid it down as a rule?—No, you have misunderstood me. I say that in the majority of cases where the meat looks healthy, tuberculosis in the animal had not far advanced, and that even if it had, there would be little risk of communicating it to the person who eats the meat. On the other hand, the meat may look healthy and yet the animal itself may have died of tuberculosis.

59. Then you say that in certain circumstances you would condemn meat that appears to be comparatively healthy and free from disease? Would you place upon the inspector the responsibility of prohibiting the consumption of anything that is doubtful, whether it was tuberculosis or not?—I do not go as far as that, for there may be cases where the consumption of meat may be allowed though the animal had tuberculosis of the lungs.

60. Would you invite people to purchase such meat at a lower price?—The system pursued on the continent works very well. I do not say that the same system would work equally well here, but people in this country do not object to take American and Australian meat.

61. We are helpless in those cases, because the meat is dressed before it comes here?—Yes, that is so. I do not think that the danger of contracting tuberculosis from eating meat derived from an animal that is tuberculous is very great. On the contrary, I think that it is very small indeed. In the case of the experiments which I made, I first of all took an animal that was prone to become tuberculous, and inoculated the peritoneal cavity in order to ascertain the effect of the inoculation, with the result which I have already stated; this is very different to eating flesh from tuberculous animals where the risk is very much less.

62. May I take it that, generally speaking, you are not an alarmist on this subject?—Not at all.

63. And as to foreign meat and provisions, which form an important branch of the subject, you are of opinion that if the meat is apparently healthy no injurious consequences are to be apprehended from taking it?—What I say is that the risk is very small.

64. Do you believe, speaking of what you have heard from other people, that human beings are capable of contracting consumption or tuberculosis from the meat which they may happen to eat?—I think it is possible that it may have occurred in some cases, under certain conditions. There have, I believe, been no cases recorded where eating tuberculous meat has been proved to produce tuberculosis in man.

65. But speaking generally, you are inclined to say that as a rule the inspector of the market or slaughter-house, who is accustomed to inspect and condemn faulty or unhealthy meat will, from the experience he has acquired, be able to guard the public from any probability of being infected by the eating of tuberculous meat?—I should prefer to rely upon the experience of a veterinary surgeon rather than that of an ordinary market inspector.

66. But in the four cases which you spoke of you say that the inspector at once detected the badness of the meat and condemned it?—Yes, that was so.

67. Then do you go as far as to say that an ordinary inspector who is fit to inspect the meat under the provisions of the Public Health Act would not be competent to detect the existence of tuberculosis?—I think that an inspector would necessarily know less than a veterinary surgeon.

68. In the cases which you have mentioned, the inspector condemned the 10 animals which gave rise to your experiments?—Yes.

69. Then you have a certain amount of confidence in the knowledge of the inspectors of meat?—Oh, yes, certainly.

70. Speaking generally, you say, in reference to these cases, that there were indications of disease in the meat which justified the inspector in prohibiting the use of it as food?—Yes, as regards the first four.

71. Then would you rely on the inspection of the meat if properly carried out under the provisions of the Public Health Act? Would that be sufficient to relieve the public mind of any fear of infection being communicated by eating tuberculous meat as an article of food?—Yes.

72. I may take it that that is so?—Yes.

73. And it is a statement founded upon your own experience and knowledge?—Yes. I only form that opinion from what I know of the result of the action of the Manchester inspectors.

74. Have you had any experience in regard to milk?—No.

75. You are not prepared to give us any testimony in regard to children dying from being fed upon milk obtained from an animal suffering from tuberculosis, the disease having been contracted in consequence of the faulty condition of the milk?—I have no doubt that disease is contracted by young children from drinking milk obtained from cows suffering from tuberculosis.

76. Do your remarks upon that point apply only to children of a certain age; you used the term "young children"?—Yes.

77. The disease is more common in young children?—Yes, I think so.

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78. Although the parents or other adults who consume the same milk may not contract the same disease, yet you are of opinion that children have died from drinking milk procured from tuberculous cows?—Yes, but it must be remembered that as a rule a child up to the age of six months lives entirely on milk.

79. I was speaking of children of 8, 10, and 12 months old. Is it not the fact that a sort of consumption appears to be contracted by young children of that age?—Yes; that is precisely what I meant.

80. Do you think that when children of that age die of consumption, it may have been caused by the milk supplied to them?—It is very common for children of 10 years of age to die of consumption, but it is more common for children under five years of age to die of it, and it is very common in the cases of children between the ages of one and two years.

81. That there is a great amount of infant mortality in some of the large towns we know?—Yes, it is particularly the case in Manchester.

82. Diarrhœa and disorders of that kind, do you think they are practically the same as consumption, and that they are produced in the same way?—No, not diarrhœa. That may arise during the consumption of perfectly pure milk. The diseases to which I refer as occurring among young children are, to a large extent, tubercular diseases of the mesenteric glands.

83. In the case of milk there is this difficulty, which must have occurred over and over again, namely, that the milk and the milking do not always come under the observation of the inspector. I do not know how much, but probably three-fourths of the milk consumed in this country, as well as many of the carcases sent to the butcher, are altogether free from any supervision of the inspector whatever. Is not that so?—Yes; and there is also the cheese, and butter, and cream, produced in the dairy, over which the inspector has no control whatever.

84. (*Dr. Buchanan.*) In the case of Manchester, public slaughter-houses are employed?—Yes.

85. You have no private slaughter-houses?—No, not that I am aware of.

86. How many animals have been condemned in Manchester as unfit for food on account of tuberculosis?—I am unable to say; I do not think there have been very many. The experiments which I made were made in regard to 10 animals. I do not believe that the number of tuberculous animals sent to Manchester is very large.

87. Have you any reason to believe that the owners of animals which are known to be suffering from tuberculosis will take care not to send them to Manchester, where they would come under the eye of the market inspector?—I have been told that that is so. I have been informed that such animals are slaughtered somewhere else, and that the dead meat alone is brought to Manchester.

88. Do you know anything of the practice in the German slaughter houses?—No, not from my own personal observation. I know, however, what I have read, and I have had conversations with Dr. Böllinger upon the subject.

89. I was anxious, if possible, to obtain some of your own views upon the pathological phenomena. You told us that you tried experiments by inoculating rabbits, and that after a certain lapse of time you found that the animals experimented upon had developed tuberculosis. Will you now tell us what parts of the rabbit were tuberculous?—I found the existence of tubercles more especially in the mesenteric glands and the peritoneum. The lungs and liver were free.

90. Did you make any experiments in the way of introducing into these animals tuberculous matter in the shape of food?—No.

91. Did you, in the experiments you made, find any evidence of tuberculosis in the intestines of the rabbits experimented upon?—No, it was entirely confined to the peritoneum and the mesenteric glands. But, of course, the animals were killed before tuberculosis could have made much progress.

92. In the case of the animals that were affected with tuberculosis, could you tell when the tuberculous process began, or did you kill them in order to ascertain?—In the first four cases, those in which the meat was perceptibly bad and unhealthy, the rabbits were killed three weeks after their inoculation. They presented a markedly emaciated appearance. In the other cases the inoculated animals were not very much emaciated, but looked very well.

93. When you say that some of the animals experimented upon were not affected at all by tuberculosis, so far as could be judged, at what distance of time are you speaking of? Did you kill them in order to ascertain the fact?—We kept some alive for two months, and some even longer. One died of another disease six months after the experiments, and no trace of tuberculosis was found in it.

94. (*Prof. Burdon-Sanderson.*) In the case of the two animals, the fifth and sixth, which were included in your experiments, and which presented a fairly healthy appearance, what was the general appearance of the organs?—The organs of the cows, you mean?

95. Yes?—They were far advanced in tuberculosis, that is to say, the mesenteric glands and the peritoneum, and the lungs also. In one case the heart was covered with a mass of tubercles. Although the meat looked fresh tuberculosis was far advanced.

96. Was the tuberculosis so much developed that the condition of the animals was certain to be condemned by any inspector?—Yes, in regard to No. 5. No. 6 probably might not; but it would very likely have given rise to a case which would have been brought before the magistrates. There was so little tuberculosis perceptible that in all probability the butcher would have considered it a good case for testing the judgment and decision of the inspector.

97. It was a doubtful case?—Yes, the tuberculosis was not very far advanced.

98. In the other cases was there pretty clear evidence of the existence of tuberculosis in the animals?—Yes.

99. In the first four?—Yes; but there again the other organs were very little affected by tuberculosis, except the lungs and the pleura.

100. In those cases the meat would most unquestionably have been condemned?—Yes, I think so; it is only with Nos. 5 and 6 where there might have been some doubt.

101. I presume that the Manchester inspector is a practical man, perfectly alive to the importance of the subject and the signs by which the existence of disease is to be detected?—Certainly; he is thoroughly acquainted with his duty, and quite able to arrive at a sound conclusion whether tuberculosis exists or not.

102. He has no hesitation in acting?—No; he discharges his duty properly, and is, in fact, very strict.

103. (*Chairman.*) In some of the cases you have mentioned, the inspector condemned the meat because he knew from his own observation that the animals were tuberculous. In the other case you have referred to, in which you say the existence of tuberculosis was not so apparent, and in which the butcher might have felt disposed to appeal to the magistrates, did the butcher consider himself injured because no one but a scientific and practical man would have detected the disease?—Yes, and there was an outcry against the condemnation of the meat.

104. (*Prof. Burdon-Sanderson.*) What office does the inspector hold in Manchester?—He is inspector of the meat market; he inspects all the meat brought into the market, and condemns it if he thinks it is unfit for food.

105. Is he also the inspector of the slaughter-houses or abattoirs?—I am unable to say; I really do not know.

106. Then you do not know precisely what office he holds?—No, beyond the fact that he is the inspector of the meat market. The specimens I

examined did not all come from Manchester, some came from Bolton, others from Liverpool.

107. In case No. 6, have you any doubt that the meat was infective, and that infection may be caused by the consumption of tuberculous animals as an article of food?—No; there is always a risk, although it may be an extremely small one. When it is taken into consideration that the meat is cooked before it is eaten, I think there is very small probability of infection being contracted.

108. You have no doubt of the infectiveness of tuberculous animals, although they may appear to be perfectly healthy; but you think that the risk, in certain cases, is very small?—Yes, I do not think that the eating of cooked meat from animals which may have been infected with tuberculosis is likely to give rise to tuberculosis in the persons who eat it.

109. Do you think the risk is so extremely small that precautions to guard against it may be neglected?—Yes, I think so.

110. But you will not go so far as to say that a human being eating tuberculous meat may not become infected?—No, I should not like to say that in any case.

111. What is your opinion about the effect of cooking the meat?—I should say that the cooking destroys the risk. The only danger would be from those parts of the meat which were underdone. I certainly think that when meat is exposed to a high temperature in cooking, the risk of infection will be destroyed.

112. Do you think, practically, that boiling, or rather, the ordinary modes of cooking, afford a sufficient guarantee against infection?—Yes.

113. Do you think that, on the whole, the most effectual protection would be to prevent the spread of tuberculosis in the animals, or to exercise a more strict supervision over the supply of meat?—I think it would be much better to prevent the spread of tuberculosis among the animals themselves.

114. How could that be done? — I suppose it might be done by the inspection of the sheds in which the animals are kept. There should be a regular inspection of the cattle and the places in which they are housed, and, in the next place, persons suffering from tuberculosis should not be suffered to serve in the cowsheds.

115. Do you share the opinion that in the immense majority of the cases which arise in cattle the disease is hereditary?—Yes, I think that is so in a great many cases.

116. Nevertheless you are of opinion that something may be done by inspection in a great many cases to check the spread of the disease?—If I said "in a great many cases," I was wrong. I should say that in animals there is an hereditary tendency to tuberculosis, as in man; but what the proportion is I cannot say.

117. Can you suggest to us no more effectual way of preventing the spread of tuberculosis among animals than by exercising a strict supervision over the cow-sheds and the cow-houses in which the animals are kept?—I think that such supervision would have a beneficial effect, in guarding against the spread of disease, where it is preventible.

118. Would it be effectual? — I should think it might be.

119. Can you suggest any practical way of carrying this supervision out?—No; but I have not followed the question at all; it has not come within my province; but I certainly think that a strict supervision would have the effect of diminishing tuberculosis in the animals. Of course, when the animals are in the open air, they are found much less frequently affected. If they are herded together, they may contract the infection. Pigs, which are very dirty in their habits, are liable to it, but contract it mostly by the young pigs being fed with milk from tuberculous cows. At the same time, I do not think that it is so important to keep the animals separate in the open air, unless they are manifestly diseased, as it is to prevent their being looked after by persons who are suffering from tuberculosis.

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120. As regards the milk, do you think that the danger of using tuberculous milk could be got rid of entirely if the custom were adopted in this country, as it is in others, of using boiled milk only?—Certainly. If it were the custom to use nothing but milk which has been boiled, I think all danger of infection would be avoided.

121. Do you know whether there is any particular reason against that practice being adopted in England?—There is none whatever, that I am aware of.

122. Can you tell us whether it is within your knowledge that in any part of Germany, or in Germany in general, the practice exists universally of boiling milk before using it?—Yes, I believe it is done to a much larger extent in Germany than in this country.

123. (*Chairman.*) Has the practice been resorted to in order to stop the disease? — No, I do not think so.

124. It is their fashion and way?—Yes, nowadays they sterilise the milk.

125. (*Prof. Burdon-Sanderson.*) In what part of Germany is that done? — In Bavaria and in other parts. In Bavaria, particularly, it is done very largely.

126. The practice is general in Bavaria? — Yes, and also, I think, in Prussia. I have been informed that Soxlett's apparatus is used largely, and in that way the spread of infection is prevented.

127. Whenever sour milk is used, is it not almost necessary that it should have been boiled?—Yes.

128. (*Prof. Brown.*) Did I understand you to say that in regard to one of the specimens of meat you employed for the purpose of inoculation you had previously made an examination, and found that it was free from tuberculosis?—Yes, three or four parts were examined microscopically, and it was found that there was an absence of tuberculosis.

129. Nevertheless, although in none of the parts examined, the presence of tuberculosis was detected, upon inoculation tuberculosis in the peritoneum was produced?—Yes.

130. You did not try any experiments in the way of feeding?—No; except upon two dogs, both of which are alive now, and very well.

131. That would indicate what I believe is an accepted fact, that dogs are not susceptible to tuberculosis?—Yes, both dogs and cats.

132. But it has been ascertained that the majority of animals which eat materials containing tubercle will become infected?—Yes.

133. Are there not a number of the parts of animals which are eaten besides the flesh?—Yes.

134. And in a case where you get typical deposits in the pleura and in the peritoneum, the heart and liver, and the ribs of beef and mutton, as well as the diaphragm and flank, all become dangerous if the food is taken in a raw state?—Certainly.

135. They are covered more or less by membranes in which the tubercle is present?—Yes, and the meat ought to be condemned.

136. The membranes of the pleura and peritoneum would be absent, I presume, and could not be condemned in the case of meat sent into the market?—Yes.

137. They are stripped from the meat?—Yes. The meat is ready dressed for the market, and I could not, in the instances I have mentioned, find any trace of tuberculosis, the membranes which would have shown the tubercles having been stripped off.

138. But they would not strip the heart?—I do not think that a butcher would offer for sale a heart that was infected with tuberculosis, as it would be so evident.

139. Have you noticed, in the membranes of the heart, tubercles that were extremely minute—not larger than pins heads—and which an ordinary meat inspector might not recognise as tuberculosis at

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all ?—Yes, I have seen that, and probably an ordinary meat inspector would not, in such a case, detect the existence of tubercles. The tubercles which I have seen in the animals, upon the meat of which I experimented, were large, and easily detected.

140. That would be so in some cases, but are there not parts in which the existence of tuberculosis would escape the inspector altogether; and if so, would not the meat be sent into the market, and be sold for consumption ?—Yes.

141. I think you said that rabbits will not eat flesh ?—Yes, I think so.

142. Have you ever tried the experiment ?—Yes, I have tried it in the laboratory.

143. We have, in practice, for years past, been in the habit of feeding a large number of rabbits, and several hundreds have been fed upon flesh. That is not your experience ?—My experience is that rabbits will not touch flesh.

144. Probably you have given them the flesh unmixed it with anything ?—We have mixed it with leaves, but the rabbits left it.

145. When it is mixed with oats and bran they will generally eat it, so long as it is fresh. I understand you to say, that in order to prevent or to diminish the spread of tuberculosis among cattle, you would prevent the entrance of a consumptive person into a cowshed ?—Yes.

146. One mode you would adopt in order to prevent the spread of tuberculosis among cattle, would be to prohibit the entrance into the shed of a consumptive milkman ?—Yes, because it is probable that the attendance of a consumptive person upon the cattle would be the means of producing tuberculosis in the animals themselves.

147. That would not be the only danger, would there not be the danger of transmitting tuberculosis by chickens and poultry, which are allowed to run about the farm-yard ?—No doubt there is the same danger there.

148. You are, of course, aware that poultry are very subject to this disease ?—Yes, they get the same tuberculosis as that which is found in cattle and man.

149. Have you tried any experiments in the way of feeding rabbits or other animals upon tuberculous poultry ?—No, but I know that poultry are very prone to be infected by the disease.

150. Not only prone to it, but that they sometimes become very full of it ?—Yes.

151. Suppose that we had, throughout this country, a very rigid system of meat inspection, or milk control, should we not still be open to the risk of contracting tuberculosis from the importation of meat which comes from abroad, already dressed ?—Yes, certainly.

152. And from dairy products, such as butter and cheese ?—Yes.

153. Is there anything you can suggest, that would enable us to deal with that difficulty ?—No, I have not paid special attention to the matter.

154. (*Chairman.*) You have already said that you are not an alarmist upon this subject ?—Yes.

155. (*Prof. Brown.*) You are aware that tuberculosis is very prevalent indeed among cattle, all over the known world ?—Yes.

156. (*Dr. Payne.*) I should like to ask you whether you think that localised tuberculosis in cattle renders the meat dangerous ?—That is very difficult to say. If the lungs are affected that would be simply local, though it is difficult to draw an exact line between local and general, and an animal may die from tuberculosis where the lungs alone are affected.

157. Is your opinion founded on experience, or upon general considerations ?—I may say that it is founded, in a great part, upon experience, and upon the experiments I have made, and partly upon the experiments which Dr. Böllinger has made in regard to meat which looked healthy. No doubt, meat that has a healthy look would entail the minimum of risk.

158. In the case of the meat which you examined you had not previously examined the carcases upon which you made your experiments ?—No.

159. Then you did not know exactly what the tubercular disease was ?—No, beyond the fact that some of the organs were affected.

160. Do you admit that the animals from which your samples were taken may have died of tuberculosis ?—I do not think so, as all the animals were slaughtered.

161. And if that was the case, or they had very nearly died in an advanced stage of the disease, would it not be easy to detect the existence of tubercle ?—Yes, in such a case the living animal would certainly show signs of tuberculosis. The animal would be emaciated and lean looking.

162. In the case of an emaciated animal being sent into the market, would not that fact alone arouse a suspicion, and probably lead to the animal being condemned as unwholesome food ?—Yes; there would be no difficulty in recognising the existence of the disease in such a case. When an animal becomes emaciated, it is a sign that it is suffering from disease.

163. Can you say whether in animals that are tuberculous, they are generally emaciated or not ?—That is not invariably the case, I know that an animal may have a considerable amount of tuberculosis and yet be very fat.

164. But you think that the meat of an animal which has a healthy look, notwithstanding the existence of tuberculosis is much less dangerous than the meat of another animal in which the disease is readily detected ?—Certainly.

165. Do you think that tuberculosis in man is the same as tuberculosis in cattle ?—Yes, I do; there are morphological differences, but I think that they are both virtually the same.

166. Are you able to say from any of your experiments, whether those parts of the flesh of animals which would produce tuberculosis in other animals, if such animals are inoculated with them would, if eaten, also produce tuberculosis ?—Not from my own experiments, but I know from experiments of others that such is the case. I have not tried the same experiment in reference to inoculation from poultry.

167. Do you think that tuberculosis in animals may be produced from associating or coming in contact with persons who are suffering from consumption ?—Yes, I do.

168. Are you aware of any case of tuberculosis having been contracted by feeding upon the meat of animals suffering from the disease ?—No, I am not aware that there is any authentic instance known of a man having contracted tuberculosis from eating tuberculous meat.

169. Have you made any experiments on animals to ascertain whether the disease may be contracted from sputa ?—I have made experiments with dried sputa, but for a different purpose.

170. Do you think there has been anything in the appearance of the morbid anatomy of a man or child dying from a tuberculous disease which would suggest that it had been brought about by eating meat in which tubercle was present ?—I have on several occasions seen the mesenteric glands affected and presenting a marked appearance of "Pearl disease," but there is great difficulty in distinguishing whether or not these appearances have been brought about by eating tuberculous meat.

171. You have sometimes had evidence that the tubercular disease has begun in the intestines rather than in the lungs ?—Yes.

172. Is that more common in the case of children than of adults ?—Certainly; much more common.

173. Is the case of children dying of tuberculous disease which has begun in the digestive organs comparatively common ?—Yes, it is known to be so.

174. Have you ever known a dog to be infected with tuberculosis ?—Yes.

175. But the instances are rare ?—They are not altogether rare, St. Bernard dogs have very frequently

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died of tuberculosis. I have known of four such instances which occurred within the last six months.

176. You do not think that experiments upon dogs are as conclusive as those upon other animals?—Certainly not.

177. Do you know any means of detecting tuberculous meat by sight, without examining the viscera?—No.

178. (*Chairman.*) There is one question which I wish to put in reference to the first portion of your evidence. You spoke of having made experiments in 10 cases. In all those 10 cases did you find that the intestines were infected as well as the flesh?—No, I only saw portions of the flesh and portions of the organs.

179. Are you able to answer the question whether the disease in the lungs was more apparent in the four cases in which you say the meat was flabby and bad than in the other cases?—Oh, yes.

180. That was so?—Yes, undoubtedly.

181. Then you would say that in the four cases in which the meat was obviously bad, the parts submitted to you showed a more advanced stage of disease than the others?—Certainly.

182. You are able to say distinctly, that that was so?—Yes.

183. Although the inspector had tarred them all with the same brush?—Yes.

184. (*Prof. Burdon-Sanderson.*) In the two cases in which the meat was not so perceptably bad, what is the best description you can give of the condition of the animals?—The meat looked quite healthy. I did not see the organs myself. Both the lungs and the pleuræ were affected, but I believe that there was only a very slight infection of the peritoneum.

185. In the whole of the cases were the lungs and pleuræ more or less infected?—Yes; in all the cases the lungs and pleuræ were infected, but the rest of the samples submitted to me did not give rise to tuberculosis in the animals experimented upon.

186. You are certain that there were tubercles?—Yes, all of them contained tubercles.

187. Even the four which gave no results?—Yes, certainly.

188. In regard to the observations you made in the case of the rabbits which you had inoculated and in which you found the existence of tuberculosis, did you make a microscopic examination?—Yes, a microscopic examination was made in every one of the cases, and every piece of meat experimented upon was most carefully examined.

189. And in every positive case the result of the examination of the rabbit was to show the existence of tuberculosis?—Yes, in every case, whilst the meat showed no tubercle.

190. (*Chairman.*) May we assume, as a matter of certainty, that in the four cases in which the meat was obviously bad the badness was due to tuberculous disease and not to anything else?—Yes, it was due simply to tuberculosis.

191. (*Dr. Buchanan.*) Are you able to say what proportion of consumptive patients show advanced stages of consumption in the intestines?—I could not state the number, but I should say that if the intestines of persons that have died of tuberculosis are carefully examined there are a good many cases in which small tubercular intestinal ulcers are found. In all the meat which I examined I found no traces of tuberculous disease.

191*a*. Have you formed any opinion as to the precedence, in point of time, of the signs of disease in the lung and in the intestine?—The result of my observation is that intestinal lesion comes on very late; that it does not come on until the phthisis is far advanced. A person affected with tuberculosis of the lungs would swallow a portion of the expectoration, and in this way the tuberculosis would be set up in the intestine.

192. Do I understand you to say that in the case of a large proportion of consumptive patients the disease began to make itself manifest before the respiratory organs were attacked?—No, I should say that the proportion was very small indeed. In most of the cases which have come under my notice the intestines have been only secondarily affected. I think that in most cases of tuberculosis the lungs would be primarily attacked.

193. Would the same observation apply to tuberculous disease in a child?—It would in a way. The tubercular virus would pass through the mucous membranes without affecting them.

194. (*Chairman.*) Then, are you prepared to say, as a consequence of the examinations you have made, that consumption does not proceed from what a person may eat, but what is introduced into the system in some other way?—In drinking tuberculous milk, the milk would pass through the intestines, which might themselves not become affected, and tubercles would, in that case, be located in the glands.

195. (*Dr. Buchanan.*) Can that occur without finding tuberculosis in the digestive organs?—Yes, I think so.

196. (*Chairman.*) That explanation does not altogether answer my question, which is, that a man may eat diseased meat and yet not manifest tuberculosis in the lungs?—I think that a person may have tuberculosis in the lungs arising from what he may have eaten. The disease, as I have just stated, in passing through the intestines, may have become located in the glands, from whence the system would become infected.

197. (*Prof. Burdon-Sanderson.*) You are now pointing to the mesenteric glands being primarily affected?—Yes.

198. (*Dr. Buchanan.*) Are you speaking of cases which have shown tuberculosis to have begun in the intestines, or of tuberculosis generally?—I was speaking principally of tuberculosis in children, of cases in which the glands have been found to be infected while the intestines were healthy.

199. In those cases you have found the indications you have described before the disease manifested itself in the lungs?—Yes, the lungs remained right until the end, or became affected only late in the disease.

200. Has that also been your experience in regard to adult cases?—No, in adults the lungs appear to become affected primarily.

201. But in children the contrary is the case?—Yes.

202. (*Chairman.*) Do you believe that consumption in anything like an appreciable number of cases proceeds from the swallowing of poisonous tuberculous matter?—No; in most cases it appears to have been produced by inhalation.

203. (*Prof. Burdon-Sanderson.*) When you say "in most cases," I presume you only mean in most of the cases in which it has been acquired at all?—Quite so.

204. Do you admit that the per-centage of cases in which the disease is acquired is very small?—Not so very small.

205. As a general rule, tuberculosis is hereditary?—Yes.

206. And, in a small number of cases only, it is acquired?—I should say, judging from my experience, that in about one half of the number of cases which occur, the disease is acquired.

207. (*Chairman.*) Does that remark apply to adults or only to children?—To adults as well as children.

208. Then you are of opinion that, in most cases, it is caught like typhoid?—This is shown by the large proportion of healed phthisis—so called—which we find in old people. Dr. Harris, assistant in the Pathological Department, has made an analysis of the proportion of healed phthisis found in persons that have died from other diseases, and this proportion reaches a very high degree with advancing age, so that of persons who die between 60 and 70 the proportion is something like 80 or 90 per cent.

209. Suppose that you do catch it from inhaling something, is there any source from which you can get it except milk and meat?—Certainly; the poison may be inhaled from dry expectoration.

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210. But that is practically the same thing?—A large proportion of cases have arisen from inhalation.

211. (*Dr. Buchanan.*) Independently of the lungs having been primarily affected?—That may be possible, for the virus may be inhaled, pass through the lungs without affecting them, and be located, say, in the lymphatic glands at the root of the lungs (*intrathoracic glands*).

DIAGRAM.

SHOWING DR. JULIUS DRESCHFELD'S RESULTS from INOCULATIONS into the PERITONEAL CAVITY of RABBITS of MEAT taken from VARIOUS SOURCES.

A. EXPERIMENTS. With meat taken from animals having tubercular disease in their lungs and in other organs.	B. CONTROL EXPERIMENTS. With meat taken from healthy animals.

The rabbits for Experiments (A) and Control Experiments (B) were all kept under identical conditions of life.

1. Rabbits inoculated with meat obviously unfit for food All developed tuberculosis in 3 to 5 weeks - -	4	1. Three rabbits inoculated with healthy meat remained well; they were killed 3 months after inoculation, and no trace of tubercle or any disease was found.
2. Rabbits inoculated with meat of questionable appearance. Developed tuberculosis in 2 or 3 months - -	1	
3. Rabbits inoculated with meat of quite good appearance. One developed tuberculosis in 2½ months, the others remained well - - - -	5	
	10	
6 developed tuberculosis. 4 remained well.		

The witness withdrew.

Adjourned until Friday, October 17th.

FIFTH MEETING.

7, Whitehall Place, S.W., Friday, October 17th, 1890.

PRESENT :

THE RIGHT HON. THE LORD BASING, PRESIDING.

Professor G. T. BROWN, C.B.
Dr. G. BUCHANAN, F.R.S.
Dr. J. F. PAYNE.
Professor J. B. SANDERSON, F.R.S.
Mr. LEOPOLD HUDSON, *Secretary.*

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Dr. GERMAN SIMS WOODHEAD, F.R.C.P., Edinburgh; F.R.S.E.; Director of the Laboratories of the Conjoint Examining Board in England of the Royal Colleges of Physicians and Surgeons.

212. (*Chairman.*) Will you be so good, Dr. Woodhead, as to describe your position and the appointments which you hold?—Do you mean my present position?

213. Yes?—I am director of the research laboratories of the Colleges of Physicians and Surgeons.

214. Of London?—Yes.

215. How long have you held that office?—About five months.

216. We should be glad to know what were your previous qualifications for that very important post?—I was director of the research laboratory in the College of Physicians in Edinburgh.

217. Did you occupy that position for some time?—Yes, for three years; I was also research scholar of the Hon. the Grocers' Company of London, pathologist to the Royal Infirmary and Royal Hospital for Sick Children, Edinburgh, and assistant to the Professor of Pathology in the University of Edinburgh.

218. I understand that your attention has been directed for some years, to subjects akin to those which are being dealt with by this Commission?—It has.

219. Before I go through the *précis* of evidence which you propose to give to us, I should like to state what our object is in examining you. We are desirous of ascertaining from you, as an expert, what your view is of the present position of the subject into which we have been appointed to inquire, namely, the point at which we have arrived as to the connection between tuberculosis in animals and consumption

in man; and whether you have anything to urge upon us, derived from your own experience and thought, as to the view we ought to take, if any, with the object of enabling us better to answer the inquiry which the Government has entrusted to us as a Commission, namely, "What is the effect, if any, of food "derived from tuberculous animals on human health; "and, if prejudicial, what are the circumstances and "conditions with regard to the tuberculosis in the "animal which produce that effect upon man?" Before I come to your evidence let me put one question to you. Do you consider that any satisfactory or decided standpoint has been arrived at in regard to the question which we have before us in connexion with animal tuberculosis and consumption as it affects mankind?—Do you mean as to the identity of the disease?

220. Yes?—I do not think that there is any distinction to be drawn between tuberculosis in animals and tuberculosis in man; but as to the proof of the mode of transmission I think that we have not yet sufficient evidence.

221. Do you think that we have any evidence as to a connexion between the two?—Yes, I certainly think that we have.

222. But in regard to the mode of communication the evidence is *nil*?—Yes, that is my opinion.

223. When you say "evidence," do you mean conclusive evidence?—I mean evidence that is conclusive to my mind, and also conclusive to the minds of a great number of other persons who have paid attention to the subject.

224. Of course I was accepting what you know to have been laid before persons of authority and experience, and ascertained by inquiry. Taking all that into consideration, you say there is satisfactory evidence that there is a connexion?—Yes.

225. There is a connexion between the two diseases?—Yes.

226. (*Prof. Sanderson.*) Do you say identity or connexion?—I should say identity.

227. (*Chairman.*) Identity?—Yes.

228. But not as to the mode of contracting the disease on the part of either class? You say that there is a similarity between the disease in both classes, and that it is marked?—Yes, in regard to both classes; but I do not think that the evidence is absolutely conclusive as yet.

229. At present you have not got that upon the evidence your desire to put before us?—No.

230. Then may I ask you if you have any suggestions upon that point which you would like to submit to the Commission?—Yes, I should like to say a word or two upon the subject.

231. Before we go further, I wish to call your attention to the fact that this is an inquiry into two branches of the question—tuberculosis as conveyed by meat, and tuberculosis as conveyed by milk. You will appreciate the distinction?—Yes, I quite understand.

232. Then, if you please, let us begin with the latter. Has your attention been called particularly to the question of ill-health in children, or, indeed, in any human being whose health has been affected in this particular way through the agency of milk?—Yes, my attention has been specially drawn to the subject in connexion with the disease in children; I mean tuberculosis in children. I have made a considerable number of examinations in regard to tuberculosis in children. In attempting to trace the disease from the alimentary canal to other parts of the body. I have examined a very large number of cases of tuberculosis—probably about 120 in all. I may say that in a very large number of those cases the disease appeared to have commenced in the alimentary tract, either directly in connexion with the intestines themselves, or in the glands connected with the intestines.

233. The disease which you are referring to as that which affects children is, I presume, that which is ordinarily known as consumption, the seat of which is supposed to be in the lungs, and which is more properly called, in the case of children, *tabes mesenterica*?—It is.

234. That is, I imagine, a disease of a similar kind, which affects the alimentary glands?—Yes.

234*a*. That is the disease you refer to?—Yes.

235. Have you found any connexion between tuberculous milk and tuberculosis in cows and in the presence of this disease in children. In the analyses you have made have you found any connexion between the two?—Yes, my attention was drawn to the subject by the experiments of Professor Bang in Copenhagen, as explained at the International Congress which was held in the year 1884, I think. Professor Bang produced a number of specimens of milk obtained from tuberculous cattle, and he was able to demonstrate that they contained a large number of *tubercle bacilli*.

236. That was at Copenhagen?—Yes.

237. At the International Congress?—Yes. It was there that the first important observations were made on the subject, and, upon that occasion, Professor Bang demonstrated the existence of *tubercle bacilli* in several specimens of milk that were exhibited. He drew attention to the nature of the disease in the udder of the cows which had furnished the supply of milk. It was found to be tuberculosis. Subsequently I examined a number of cattle in Edinburgh. I had been appointed to the Grocers' Company Research Scholarship, and I, along with Professor McFadyean, examined a number of cattle, and we demonstrated the existence of tuberculosis in a certain proportion of the cattle which supplied milk by finding *tubercle bacilli* in the milk.

238. Can you say whether the people who were in the habit of using the milk you speak of were consumptive beyond the average? Were you able to identify those who used it in any way?—No, we could not do that; at the time we made our examination we did not know to whom the milk was supplied. Our inquiry had reference to the general question whether *tubercle bacilli* could be found in the milk which was supplied from particular dairies.

239. Did you not make it a point of your inquiry under the circumstances to ascertain whether a disease of this kind was specially prevalent in Edinburgh?—Well, we believed that the same conditions existed in every town in the kingdom, and that they had been going on for some time.

240. To what class of society do you particularly allude as being principally affected by this tuberculous milk?—My observations apply mainly to children of a weakly condition.

241. Do you mean children of the poor?—Yes.

242. Unhealthy children?—I mean children of a weakly condition who had temporary disease of the alimentary canal, and who, under such conditions were likely to be affected by the ingestion of milk of this kind—milk containing these organisms. The only opportunity I had of examining the children was in the case of sick children in the hospital. Of course they were children which belonged to the lower classes.

243. Is it the result of your experience that the children of the lower classes in this country are those which consume most milk?—No, but they are children who are in a condition to be more easily affected than the children of other classes.

243*a*. As a matter of fact, is not the reverse rather the case, that the children of the poorer classes are lamentably and notoriously deficient in their milk supply?—That no doubt is so, but they get the same milk as that which is given to other children. When I say that the taking of tuberculous milk is the cause of disease in children I do not mean to say that it is the cause of tuberculous disease in a thoroughly healthy child. What I mean is that milk passing through the alimentary tract at a time when the constitution of the child may have been temporarily weakened or affected, or when the alimentary tract itself is out of order, perhaps only temporarily, may produce disease; and that under such conditions tuberculous infection may

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take place. It was in this class of children that we found the large proportion of cases.

244 Then will you go so far as to say, as the result of your experience, that infection from what may properly be called tuberculous milk is only to be apprehended in the case of children who are predisposed to disease?—Yes; predisposed either temporarily or permanently.

245. Then I take it that you do not view with any alarm the general use of milk throughout the kingdom, although you are aware that a number of the cows from which it is supplied may be infected with tuberculosis?—I do view it with great alarm, as I know that such milk is being supplied to children who are not in a sound state of health.

246. We all know that there is a great infantile mortality in this country in our large towns? You are of course aware of that fact?—I am.

247. Then do you go as far as to say that the condition of the milk supplied to children has nothing to do with that?—I have no doubt that it is a most important element, an element which ought to be taken into most serious consideration.

248. I may probably be labouring under a delusion, but I have been induced to believe that the reason these children die so rapidly, and present such a fearful rate of mortality, is not the use of milk as food, but rather the want of it?—No doubt some of the excessive mortality is due to the want of good milk, but it is also due in a very large proportion of deaths among young children to the ingestion of material containing in some form or other that which is injurious to badly-nourished children, especially when the alimentary tract is not in good working order. In such cases, if *tubercle bacilli* are in the milk supplied, it may be the means of infecting them with tuberculosis. But what I say is that if a predisposition to tuberculosis were not there a large number of children who partake of tuberculous milk would be spared from infection.

249. Do you draw any distinction between the use of milk and the use of butter made from milk?—Well, I have not had an opportunity of studying that point personally, but I have seen Dr. Bang's results. Rabbits fed with butter made from tuberculous milk were, in a certain proportion of the cases, infected.

250. But I am talking of mankind, and I want to know if there is any perceptible difference in the way in which children belonging to different classes of society are affected. In the first place, the children of the poor would not to any large extent get butter at all, at any rate, at the age when they appear to be mostly affected by tuberculosis?—All I can say is, that I think in the case of butter, the danger is certainly less than in the case of milk. In most cases the butter would only be taken in conjunction with other solid matter.

251. Are we to understand that in your experience you have examined cases in which it has been possible to trace disease through the use of milk?—No, I could not say that.

252. You may argue, as you have undoubtedly a right to do, that that must be the consequence, judging from the general information you have got, and your examination of the milk submitted to you?—In the case of a human subject it is impossible to get direct evidence, because, as a rule, it would be found that the moment tuberculous milk was discovered the supply would be at once cut off. It would, therefore, be impossible to carry out any connected series of experiments.

253. I do not know what the state of things is now, but I believe that in times past the registrars in their returns gave the cause of the mortality?—That is the case now, where the cause is ascertained.

254. Cannot the doctors in the great majority of cases trace the connexion between disease among children and the use of milk of a dangerous character?—I think it might be done if it were set about systematically.

255. Let me go back to what I was suggesting just now. Is it not the fact that the doctors if they were asked would say that many of the children are thus infected because they do not get proper food, and are fed upon articles, in lieu of milk, the use of which is condemned. For example, is that not the case in the town of Leicester?—Some persons would say that that was the actual cause of disease, while others would say that it was the intermediate cause.

256. Apart from your experience, are you prepared to lay down the proposition that the use of tuberculous milk is a great cause of infantile disease and mortality, particularly where the results are shown in a gradual wasting away?—Certainly.

257. You have no doubt that that is so?—None.

258. You have not been able to prove it by experiments?—I have not.

259. Not by actual experiments?—No, the history of most of the cases is very obscure. The children belong to a class of society who do not, as a rule, take the greatest care of their children. They pay very little attention to what is given to the child, or what the condition of the child is as to its general health. It is very difficult to get reliable information upon such a point as that.

260. Let me now ask you a general question upon the second of the two points I mentioned. Let me direct your attention to the use of tuberculous meat. What, in your opinion, is the effect upon a human being of eating meat from an animal which has been infected with tuberculosis?—That is a case in which, I think, we have not nearly such strong evidence as in the case of the effect which may be produced in young children by taking tuberculous milk. At the same time, I think that evidence in the same direction has been gradually accumulating. There is, however, no direct evidence that there is a positive connexion between tuberculosis in a human being and the eating of tuberculous meat. I presume that you are speaking of the conveying of disease from the eating of tuberculous meat, from the animal to man. There are, no doubt cases where the viscera and the internal organs are affected, by which tuberculosis can be produced by inoculation or by the ingestion of this tuberculous matter. The experiments which have been made are very contradictory in regard to the effect produced by the actual juice of infected meat. But I think that positive evidence is accumulating. A number of experiments have been tried, particularly in France, with the view of proving or disproving the fact that the juice of meat not obviously tuberculous itself, but taken from animals in which the viscera are tuberculous, when inoculated into animals may give rise to a tuberculous infection. The earlier experiments were said to prove that there was a connexion between the two, whilst other experiments have been made more recently from which it is said that it is impossible to establish the connexion. It is contended that it is impossible to produce tuberculosis with any degree of certainty from inoculation, or, at any rate, from ingestion of the meat of a tuberculous cow. A different result was arrived at in another series of experiments. It was found that the juice taken from the flesh of tuberculous animals, or from a human subject who had been infected with tuberculosis, as established by a *post-mortem* examination, has actually produced tuberculosis in rabbits.

261. We have heard all about that, and perhaps there is no necessity for going over the point again. It is, I believe, generally admitted to be the fact?—By many, though some deny this.

262. I gather from what you told us just now, that you think there is a wide step between producing this disease by means of inoculation and the assumption that the same disease is to be produced by the use of flesh in the form of food?—Certainly, that is my opinion.

263. Particularly in regard to the fact that the flesh made use of as food is probably cooked?—The meat may not be thoroughly cooked. Very frequently the centre of a joint of meat served up for food has not been subjected to a sufficiently high temperature to destroy the *tubercle bacilli.*

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264. We know that in this country meat is sometimes eaten underdone, but practically speaking, the cooking has a tendency to get rid of the risk?—Certainly.

265. It would in most cases remove any danger of infection from tuberculosis. It would prevent inoculation from a tuberculous animal?—Yes, but we can only argue from the evidence before us. In the case of milk, tuberculosis has certainly been produced by its being taken into the alimentary canal.

266. But the use of milk is continuous from day to day. Frequently it is the only food of the child, and we may assume that a cow goes on giving milk from day to day, and from month to month, whereas the use of meat varies. It does not follow that all meat is infected because one animal is found to be infected. Does not that remove the risk in the one case as compared with the other?—It is not necessary that a patient should consume tuberculous meat for any length of time in order that he may become infected with tuberculosis. He might eat a sufficiently large quantity of tuberculous meat, containing *tubercle bacilli*, at one meal to induce tuberculosis.

267. Then, generally speaking, the digestive organs can be made the medium, through the consumption of meat, to convey infection in the same way as the consumption of milk?—I think so.

268. But there is a great difference between the two, I apprehend?—No, I think not.

269. I am not speaking professionally, but simply in a popular way, and I would ask if you would not select a more effective material for entering into the system than meat?—Not necessarily. Meat may contain only a small number of *tubercle bacilli*, while milk may contain a very large number; or the state of things may be reversed.

270. At all events, I understand you to say that it is a long step from inoculation by the direct introduction of diseased matter under the skin or the flesh of an animal to assume that in the ordinary process of eating and digestion a similar risk of infection may be incurred?—Certainly. The process of inoculation is merely used as a means of proving the presence of an infective agent.

271. I understand that in Copenhagen the authorities have taken steps very much in advance of any that we have taken?—Yes, that is so.

272. Do you think that the steps they have taken are reasonable?—Yes, I do think so.

273. Do you know anything about the present mode of operations in Copenhagen in this respect?—Yes.

274. Will you kindly explain to us what they are?—I was there in the August before last, and I spent a considerable amount of time in visiting the slaughter-houses both by day and by night.

275. Will you state, as clearly as possible, what the plan pursued in Copenhagen is?—The assistant inspector goes round and inspects every animal that is slaughtered.

276. In the kingdom?—No, only the animals that come into Copenhagen.

277. Copenhagen only?—Yes.

278. It is a system of inspection that takes place in Copenhagen and applies to Copenhagen only?—Yes.

279. What is the practice?—The meat is placed under two classes. Arrangements are made by the inspectors for two distinct categories of meat. First of all there is the meat which is killed in Copenhagen itself and in the second place there is the meat killed outside Copenhagen and brought into the city for consumption. In regard to the cattle which are killed in Copenhagen the inspector goes round and carefully examines every carcase, in order to discover, if possible, whether there is any trace of disease of any kind in it. Any animal that is suspected of having been diseased during life or that shows signs of disease after death is set aside and an inspector goes round and examines the whole of the carcase in the slaughter-house; any animal that is found to have been infected with tuberculosis is examined thoroughly. The bodies are cut up and carefully inspected in order to discover any trace of *tubercle*. The glands are examined: the pleura, the peritoneum, the chest, the abdomen and intestines. Every organ is examined separately. If general tuberculosis is found to exist the whole of the body is condemned—that is to say, if there are traces of disease in more than one or two portions of the carcase. In that case the whole of the animal is condemned, and it is boiled down for the fat which may be contained in it, which is used, I think, in the manufacture of soap, but no part is allowed to be sold for consumption as food. If it should appear that the animal has only been partly infected, that it is local tuberculosis only, and that the walls of the serous cavities and most of the organs of the body are not affected, it is kept for further inspection. The inspectors then confer with one another in regard to what ought to be done with the carcase, whether the whole of the animal should be condemned or whether certain portions of it should be allowed to pass and be sold for food. If they find evidence of the rapid spread of tuberculosis, even although the disease be apparently localised, the whole of the carcase is condemned. But if the tuberculous region is confined to one point only—the lungs, for instance—to a single organ, and the walls of the thorax, the chest, and abdomen are unaffected, they allow those portions of the animal which are not affected to be consumed. Sometimes the inspectors condemn only the parts about the chest; sometimes the parts about the loins; in that case, if they find that the disease is localised, they may eventually allow the limbs to be sold for consumption as food. I may tell you, however, that the inspectors think that this is a mistake. They say that if they had the power, they would condemn the entire carcase, and they are desirous of getting increased power in regard to condemnation.

280. Although they are at present prohibited from condemning every animal that is only slightly infected, they would, if permitted by law, destroy the whole?—Precisely so.

281. How do you know that that is the view of the inspectors in Copenhagen?—I spoke to one of the principal inspectors, Dr. Rasmussen, on the subject, and he informed me that that was the case.

282. Are they controlled in their proceedings by the authority of an Act of Parliament?—Yes.

283. And is it the fact that no meat is sold for consumption except under their directions?—Absolutely none.

284. You say that the action of the inspectors is confined to Copenhagen?—Yes, to animals killed inside Copenhagen, or to the meat brought in for consumption from outside.

285. Are these regulations submitted to without objection by the population?—Yes, they appear to submit to them most willingly.

286. Are you aware whether the owners of the cattle, whether producers or purchasers, have submitted without reluctance to the inspection and to the conditions imposed by the inspectors?—The present system of inspection was instituted in January 1888, but since 1885 there have been 15 slaughtering cells, which might be hired by any butcher, but it was entirely at his own option. If these cells were used the meat had to be inspected and stamped. These cells were always sought after, as the butchers considered that the stamp gave their wares a good name with the public. They also started among themselves a system of mutual assurance, which is now compulsory.

287. How long has it been in existence?—I am unable to say exactly how long it has been in existence. It has existed for at least a couple of years, but I cannot say exactly.

288. Is there anything given by the State in the shape of compensation?—I think there is a certain subsidy given by the State or by the town authorities.

289. You do not know to what extent or in what proportion?—No.

290. Am I to understand that what you do say is that the owners of the cattle get compensated three

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times over—first by the State, then by the rates, and thirdly by the adoption of a mutual assurance system? —It is all done by the mutual assurance system; there is only one fund.

291. Does the State subscribe to the mutual assurance fund?—The money, in reality, comes out of fees paid at the slaughter-house. There is a charge of so much for each animal that is slaughtered, and so much for each inspection. The farmers and owners contribute a certain proportion of the fees for each animal they slaughter.

292. I understand you to say that, in your opinion, this system works well in Copenhagen?—Yes.

293. Are you here to advocate the adoption of a similar system in this country?—I am scarcely in a position to advocate any special system at present, I only wish to point out what is good in it.

294. Are you aware that the system has been long enough in progress to justify the assertion that consumption in man and tuberculous disease in children have been very much diminished, in consequence, in Copenhagen?—The authorities say that it is not possible to overstate the advantages of the system.

295. Have the authorities in Copenhagen endeavoured to support this strict system of administration by an inquiry as to the actual result?—Yes, I believe they are engaged in making an inquiry now and it is proposed to publish the results.

296. How long has the system of inspection been going on?—I cannot say exactly.

297–8. Do you happen to know, as a matter of fact, how this very strict practice in regard to the dealing with meat in Copenhagen was brought about? Was there any public alarm, or in what way were the public aroused to the necessity of imposing restrictions upon the slaughter of cattle and the sale of meat for consumption as food?—You are probably aware that tuberculosis has been very prevalent in Denmark, both among the cattle and among the people. I believe that special attention was drawn to the matter by the veterinary authorities of Copenhagen, who have made a special study of the subject of tuberculosis. As the result of their experiments these regulations have, I believe, been gradually formulated.

299. Are they in the nature of municipal regulations, or are they carried out by Act of Parliament?—By Act of Parliament.

300. Is it an Act of Parliament which applies to Copenhagen only?—It has only been applied to Copenhagen so far.

301. As far as you know?—Yes.

302. Has it occurred to you to think out the problem that would be involved if an endeavour were made to extend the same system to this country?—Yes, I have thought of it.

303. Will you be good enough to give us the result. But, first of all, do you think it is a system that might be carried out in this country?—I think it might.

304. Is that on the assumption that there is to be a prohibition against the use of meat except that which is purchased in the public markets, and which has been the subject of inspection?—Yes.

305. You do mean to say that a man may not kill his own animal on his own farm and devour it if he likes?—Most certainly I do; I think that that ought not to be allowed.

306. You do not?—No, I think that animals killed in that way should also be subjected to inspection.

307. (*Dr. Buchanan.*) The dead meat brought into Copenhagen at present is inspected?—Yes.

308. (*Chairman.*) I assume that what you have stated applies not only to all the animals brought into Copenhagen and slaughtered there, and to the dead meat brought in from the outside, but also, practically, to a cordon drawn around Copenhagen?—Yes, there are certain inspectors appointed for the city, and there is a large place within a short distance of Copenhagen which is used as a general slaughter-house. Then, again, at the railway station is a central office, where all the meat coming in is inspected just as rigorously as in the slaughter-house.

309. Then you hold, of course, that to be effective the inspection should take place in the slaughter-house, and not at the butchers' shops?—Yes, and no meat should be passed or allowed to be sold for consumption until it has been marked. Of course, all that is allowed to be sold, after it has been inspected, is marked as having been passed either in the slaughter-house or in the inspector's office.

310. Are there no butchers' shops?—Yes, but the butchers are not allowed to sell the meat unless it has been stamped by the veterinary inspector.

311. Do the inspectors stamp every joint?—Yes, every part that can be cut.

312. Are we to assume that each carcase must be cut up at the slaughter-house, and reduced to pieces for sale in the shops, and then marked?—No, I do not say that; but the butchers keep the marks on the pieces they offer for sale, as far as it is possible to do so, in order to show which is first-class meat and which is second-class.

313. The meat stamped for sale is classified under two heads?—Yes, first and second class. Animals may be slaughtered outside the city, but before being admitted for sale in Copenhagen, the meat must first pass the control stations to be stamped, as no unsound meat may be sold in Copenhagen. There are four of these stamps: 1. The city arms within a blue circle, 1st class (Animals slaughtered in public abattoirs, and all parts passed as sound): 2. The city arms in a blue triangle, 1st class (Animals killed outside the city, but inspected at the control stations, when all parts are found to be quite sound): 3. The city arms in a black circle, 2nd class (Animals slaughtered in public abattoirs, certain parts slightly affected and destroyed, the remainder passed by the inspector, and marked as fit for food, but not first class): 4. Black triangle, 2nd class (Animals killed outside the city, but inspected within, classed as good meat, but from an animal parts of which have had to be destroyed). Where the whole of an animal is not brought for inspection, but when such parts as are brought are sound, they are only stamped 2nd class. The same price is charged for the inspection of a carcase at the control stations as for the use of a booth in the public abattoirs and inspection combined, so that every inducement is offered to honest dealers to bring their animals into Copenhagen to be killed and inspected. They get all the advantages of a splendidly-equipped abattoir for nothing, in addition to which condemned meat that has been killed in the public abattoirs is compensated for out of the insurance fund, whilst meat killed elsewhere, when brought to the control station, is inspected at the owner's risk, and, if it is condemned, the owner receives no compensation. The income from these external control stations is one of the chief sources of revenue for the support of the whole system, as the mere cost of inspection is comparatively small.

314. If similar regulations were carried out in this country would they not operate to restrict the use of meat. Would you apply them in the case of all meat or would you restrict them to the case of beef?—They might be restricted to the case of cattle, calves, and swine as regards tuberculosis, but all meat should be stamped if this system were to be adopted.

315. What you suggest is a prohibition against the use of the meat of oxen, cows, and swine, unless it is sold under a system of public inspection?—Yes.

316. And a certificate given that the meat is fit for food?—Yes.

317. And you think that in this country, as in Copenhagen, which is only a single town, it might be possible by the establishment of mutual assurance societies among the farmers and butchers, supported by something contributed out of the rates, something out of the taxes, and fees, to satisfy the producers on the one side and the public on the other that such a system can be thoroughly carried out without an injurious effect either upon the health of the consumer or the pocket of the trader?—Yes, I do not see how the pocket of the trader could be affected injuriously.

318. We have not reckoned up the cost of the inspection?—That is covered entirely by the charges which are made for the inspection.

319. Who pays the charge?—The owners of the cattle.

320. Do they insure against that as well as against the consequence of disease?—No; the owners pay a small sum. The premium for the insurance fund is compulsory for all animals killed in the public abattoirs, and the fee is collected along with the gate money.

321. The owners who bring the cattle to the slaughterhouse?—Yes.

322. Is there a certain sum paid for each head of cattle sent to be slaughtered?—Yes, for every animal brought in to be slaughtered.

323. Then that is in addition to the other charges connected with the slaughter of the animals?—Yes, it is a charge which falls only upon the persons who bring the cattle for slaughter; but they cannot gain any benefit from the mutual assurance associations unless they pay that sum in addition to the sum paid to the association. I think I have here the exact sum that is paid. The premium is about 1*s.* per head. The sum demanded for slaughter and inspection, or for inspection alone, is two krohne for each cow. That will amount to about 2*s.* 3*d.* of our money.

324. 2*s.* 3*d.* for each cow?—Yes. For an ox, bull, or cow, 2*s.* 3*d.*; for a horse, 6½*d.*; for a pig, 1*s.* 8*d.*; for a calf under 300 lbs., 6½*d.*; for a sheep or lamb, 3¼*d.* Having paid this gate money to the abattoir doorkeeper (not to the yard gatekeeper), a division of 200 square feet, fitted up with every convenience and contrivance to facilitate his work, is allotted to the butcher here. He kills any number of animals, paying for each at the above rates. He hangs up the carcases, which are regularly inspected, and, if in good condition, stamped. For a small extra sum he has the use of a cooling room, which is kept at two or three degrees above freezing point by means of a current of cold air, but he is at liberty to remove the carcases as soon as they are stamped. I see from the statistics I have here that more than 16—nearly 17—per cent. of the cattle sent to the slaughterhouse in Copenhagen are found to be tuberculous. These are the returns for the year 1888. In addition the percentage of pigs found to be infected with tuberculosis was 11·4. With regard to calves, the percentage is very small.

325. (*Dr. Buchanan.*) The percentage of calves found to have tuberculosis is only small?—Yes; but of those which are brought in from the country 6·4 per cent. are found to be tuberculous.

326. (*Chairman.*) Is there any number kept back and not sent in?—Probably.

327. What is the result in the case of sheep?—Sometimes, but rarely, they are found to be badly infected with disease.

328. Taking the case of cattle; you say that nearly 17 per cent. of the meat brought for consumption into Copenhagen is destroyed?—No, I do not say that. What I say is that nearly 17 per cent. of the carcases are found to be infected with tuberculosis, but the inspectors do not confiscate the whole of the meat if they find that the tuberculosis is localised. They say they would do so if they had the power.

329. The inspectors are desirous of doing so?—Yes.

330. But the law does not go as far as that?—No.

331. Then the law devolves upon the inspector the tremendous responsibility of deciding what is and what is not dangerous for consumption?—Yes, they have absolute power in the matter.

332. Who?—The inspectors.

333. What I am thinking of is the way in which the inspector is called upon to exercise his discretion. He is not to condemn all the meat of an animal which has been found to be infected with tuberculosis, but he is permitted to allow the use of tuberculous meat as food to a certain extent?—Yes, to a certain extent, where he finds that the infection has been localised, and has only affected a certain part of the animal.

334. Although they are of opinion that the whole of the animal in which tuberculosis is found to exist should be prohibited as an article of food, they do not, as a matter of fact, exercise that responsibility, and order it to be destroyed?—No, but they mark the meat as not being thoroughly sound.

335. (*Prof. Burdon-Sanderson.*) Is that what is meant by second-class meat?—Yes, and it is a warning to the consumer that before being eaten it must be thoroughly cooked.

336. (*Chairman.*) I presume that with this warning the meat is sold to poor people at a few pence per pound cheaper than that which is marked as first-class meat? Do the people purchase it readily?—No; as a matter of fact they do not like to buy second-class meat at all. Every person is anxious to buy first-class meat, and whenever he can afford, he does so.

337. Do you know to what extent the absolute destruction of bad meat takes place in Copenhagen on a particular day or in a particular week?—I should say that there are about 1,000 lbs. of bad meat per diem on the average at the slaughterhouse alone, of which 250 lbs. is tuberculous.

338. Upon the average?—Yes.

339. Out of how much? What is the total quantity per day on the average?—About 100 cattle and 250 sheep are slaughtered. There are also a number of pigs, both in the summer and winter, but the number is not large.

340. I understood you to say that 17 per cent. of the animals—the beasts—sent into the market have been found to be tuberculous?—Yes, nearly 17 per cent.

341. And that as much as 1,000 lbs. per day will be, on the average, confiscated?—Yes.

342. What is the gross number of pounds weight of cattle brought into the market at Copenhagen?—I really cannot say.

343. But those which are tuberculous constitute nearly 17 per cent.?—That is the percentage of the animals found to be infected with tuberculosis, but not the percentage of meat that is actually destroyed.

344. What proportion of the 17 per cent. is actually destroyed, and what is the proportion that is considered to be second-class meat and allowed to be sold?—I could not tell you that.

345. Are there any means of ascertaining?—I think that if you obtain the weight of the cattle and of the pigs sent to the market it would be easy to ascertain approximately.

346. If we could obtain reliable statistics of this nature in reference to the Copenhagen Market they would, I think, furnish us with information which would not only be interesting but of considerable value?—I think the statistics can be obtained. [*These are printed at the end of this Witness's evidence.*]

(*Prof. Brown.*) We can get them here without much trouble. There are plenty of statistics of this character sent over from Denmark to this country. I believe that bullocks are reckoned to run about three to the ton. That would give about 7 cwt. each, and pigs would run about 70 lbs. each.

347. (*Chairman.*) I find that tuberculosis is much more rare in pigs than I should have supposed. I am guided by your statement?—It is about 11 per cent.

348. But pigs have another disorder, which is still more important; I refer to *trichinosis*; is not that so?—Yes, but *trichinosis* is not so formidable in Copenhagen as it is in Germany.

349. Is it as formidable as tuberculosis?—No, I think not.

350. Not as dangerous to health?—I do not think so.

351. The question whether tuberculosis can be conveyed, either through meat or through milk, suggests another question to my mind, namely, to what extent it may be said that consumption is a disease that may be contracted in some way *ab extra* and not inherited. Can you give any information upon that point as the result of your experience?—I should say that the inheritance of the disease is

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extremely rare. I think that there are not, at any rate, more than about three cases recorded in young animals, calves, for instance.

352. I am not referring to animals but to mankind?—In mankind there have been very few well-authenticated cases in which the disease has arisen from congenital causes.

353. You are speaking of consumption?—Yes, I have made a considerable number of *post-mortem* examinations, but I have only seen one case in which there was any possibility of the disease having been congenital.

354. (*Dr. Payne.*) Will you explain what you consider to be hereditary consumption? — I would not use the word "hereditary" but "congenital." Congenital tuberculosis I should regard as tuberculosis that might be contracted in the womb, and I have only seen one case in which that could have been possible.

355. (*Chairman.*) Do you go so far as to say that when a great life insurance company regards with the utmost suspicion the application of a man to insure his life whose parents may have died of consumption it is merely a phantasy on the part of the company?—I should not say "phantasy" because the conditions which existed in the parent will, to a certain extent, probably be the same in the children, but there may be hereditary weakness without the child being in a tuberculous condition. In that case the weak condition of the tissues may render the child much more delicate and weakly, and more likely to contract tuberculosis than a more healthy child.

356. I rather gather, then, that, in your opinion, all consumptive disease in mankind is either contracted through the nostrils or through the mouth?—Yes, or through actual inoculation.

357. Just as in the case of typhoid fever?—Yes.

358. In that case a specific disease is established by inhaling or ingesting poison, and I understand you to hold the same doctrine in regard to consumption?—Certainly.

359. Precisely so, you think it is contracted in the same way?—Yes.

360. Are you of opinion that if the Copenhagen system were adopted in this country there would probably be a rapid and immediate falling off in the victims of consumption?—It might not be immediate, but there would, ultimately, be a considerable falling off.

361. I mean by "immediate" as soon as possible. That would be so, you think, as the result of adopting in this country the system pursued in Copenhagen?—Yes, I think so.

362. Those who have not got tuberculosis inside them would not get it if this system were in vogue?—It would not cut off all sources of infection, but it would go a great way towards doing so.

363. It would not, for example, cut off what people might inhale?—Just so; it is only one of the precautions which will have to be taken before we can deal with the subject of consumption effectually.

364. (*Dr. Buchanan.*) Can you give us any notion, from your own experience or from having thought over the subject, in regard to the universality of *tubercle-bacilli*?—*Tubercle-bacilli* are always found where you have a phthisical patient. It can be demonstrated much more easily in the case of a phthisical patient than in other cases.

365. (*Chairman.*) What patient? — A phthisical patient—a consumptive patient.

366. Is there no such thing as a consumptive patient contracting the disease through the nostrils or his swallow?—Yes, the *bacilli* are there after the patient has contracted the disease.

367. (*Dr. Buchanan.*) Where would you proceed to look for the *tubercle-bacilli*?—I should expect to find bacilli in the mucus of the throat, and in the parts about the larynx, sooner than in the intestines. Probably they would be first detected in the mucus of the throat. *Bacilli* have been found in very large numbers in the hospitals, in hotels, and in rooms a short time after patients suffering from tuberculosis have been brought into them, although they were not there previously.

368. Are the *bacilli* found in such conditions responsible for the consumption that we see in the human subject?—They are the actual exciting cause of the disease. They are responsible in so far as they are the actual exciting cause of the disease. Of course, that is only my opinion.

369. And where would you look for the *bacilli* that are responsible for the existence of tuberculosis?—I should look for them in the mucous discharge, or possibly in the moist breath. These discharges, both from phthisical human subjects and from tuberculous animals, contain *tubercle-bacilli*.

370. Then do you think that the mucus of the infected animals is accountable for the extension of tuberculosis? — Yes, either the mucus from the infected animals or from the attendants.

371. Or from the attendants?—Yes.

372. How long does it take before an animal shows evidence of the existence of tubercle after it has received tubercular infection in this way?—It would depend very much upon the condition of the animal to begin with. If it were comparatively well and strong a considerable length of time might elapse before it would show evidence of infection by tuberculosis. But if it were in a weak condition to begin with the disease would probably spread much more rapidly, and would be much more likely to become generalised.

373. Does the age of the animal make much difference?—Yes, the older animals in a herd of cows are more readily affected than the younger ones. Tuberculosis is comparatively rare in calves, and until the second or third year the liability to infection with tuberculosis is not very great. It is more marked after the milk-bearing period has arrived; in fact, after that has well commenced it is much more common.

374. Then how do you account for this fact, that calves live very much upon milk; that, to a very large extent, tuberculous milk is supplied to them, and yet the calves themselves which feed upon it do not show any manifestation of tuberculosis until they are two or three years old?—If the calves are comparatively well to begin with they would digest the milk without being infected by it, at any rate the *bacilli* would pass through the alimentary canal unchanged, or if they got into the glands they would be destroyed. But if the calves are not healthy to begin with they become infected, either by the milk given to them or by being suckled directly from a cow which is suffering from this disease. In addition to which a great number of the weakly calves are slaughtered before there is time for the disease to become developed, as only the strong, healthy calves are kept as a rule.

375. Is that milk sent into the market for human consumption?—Yes, I am afraid that that is the case, and that it is done very frequently.

376. Can you tell us anything about the extent of *tabes mesenterica* in children as compared with phthisis in adults?—I cannot give you anything in the shape of an exact proportion. It is, however, a very large proportion, and the system of registration is more perfect now than it was formerly. At one time there were a number of cases which were supposed not to be tuberculous, but which are now registered under the heading of tuberculosis.*

377. Can you give us any idea of what the experience derived in Copenhagen has been in regard to the cooking of meat?—The cooking of meat?

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*	1851–60.	1861–70.	1871–80.
Death-rate from—	Per Million.	Per million.	Per million.
Phthisis - - -	1,305	963	767
T. meningitis hydrocephalus.	2,539	2,213	1,800
Tabes mesenterica and scrofula.	1,920	2,267	2,550

Taken from Registrar General's Supplement, 1871–80.

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378. Yes, of the meat obtained from animals which have been infected with tuberculosis. Is it the general custom to cook it with any special care? You have mentioned the fact that second-class meat, or meat of an inferior quality, is allowed, under certain circumstances, to be sold for consumption. Are the people who buy it warned against eating it in an undercooked state?—Yes, by the fact that it is marked with the black stamp.

378*a*. Have you any knowledge as to what the custom in Copenhagen is in reference to the cooking of meat. Are they in the habit of eating meat underdone, as many English people eat it?—No; I think they cook their meat better than we cook ours. That is, certainly, my impression, and the impression of all those to whom I have spoken on the subject.

379. Have you any evidence to give us in respect of milk and butter, as to the duration of the life of the *tubercle bacilli?* For instance, is salted butter, after it has been kept for some time, likely to be more free from active bacilli?—Butter made from tuberculous milk may be kept for a considerable period; in one case it was kept for three months, and the bacillus in it was virulent during the whole of that time.

380. The bacilli were virulent, and not dead?—Yes.

381. Is there any process applied to milk, in Copenhagen, besides boiling; any process of an antiseptic nature?—No, I do not think that anything of an antiseptic nature is used in Copenhagen, in connexion with the milk supply. I may say that the most careful arrangements are carried out for eliminating any cow which is infected with tuberculosis from the milk supply. That is done at the instance of a large association which was started in Copenhagen about 10 or 11 years ago. The cattle of every farmer who supplies milk to this association are inspected fortnightly by a veterinary surgeon, who goes round and inspects them most thoroughly. I was informed by one of these inspectors that a cow which has a cough, or the slightest symptoms of tuberculosis, even if the fact cannot be at once decided, is thrown out of the milk supply, and the farmer who owns it is compensated by the association during the time it is out of the supply, even if it is found ultimately that it is not infected with tuberculosis. If it is found that tuberculosis does exist, the farmer is not compensated. The milk supply for this association in Copenhagen is provided for by from 1,100 to 1,200 cows, and they are inspected fortnightly; first of all for general tuberculosis, and then for the existence of local tuberculous disease, and then for any other disease.

382. Are the inspectors, who make the examination the Copenhagen meat inspectors?—No, they are a separate body of veterinary inspectors, who act for a private association.

383. A private association?—Yes, with a large staff of inspectors, and a most elaborate system for checking the source of all the milk that it supplies to Copenhagen. The system of inspection is extended to the cows, as well as to the milk.

384. How far is the system local or imperial?—It is absolutely a local association, and it has been copied, I believe, by a considerable number of other countries.

385. (*Chairman.*) I think this is most important, and I should like to put a question. (*To witness.*) I thought you said just now that the system of inspection carried out in Copenhagen is based upon statute law?—Yes, but I am referring now to the milk supply. The inspection under Act of Parliament applies to the meat supply. I might state that the municipal authorities of every town in Denmark have power to make laws as to the inspection of all kinds of food, and it is only necessary that these should be signed by the Minister of Justice; so that full powers are, as a rule, applied for only by the large and important towns. In Germany the inspection is compulsory by Act of Parliament.

386. (*Dr. Buchanan.*) Are there associations of a similar kind in other parts of Denmark?—I do not think that it is carried out in any other part of Denmark; but there are no large cities except Copenhagen. A similar system is carried on in Stockholm, in Sweden, and in some other countries.

387. Has it been found that the operation of such an association, in connexion with the milk supply, has been to send all the tuberculous and suspected milk away from Copenhagen to other parts of the country?—The farmers supplying milk to the Copenhagen Milk Supply Association are at liberty to do what they like with condemned milk, and it is frequently used for butter making; but the better farms throw it away, or boil it thoroughly and use it as food for pigs. At one farm—Gunderup, Kjoge—that I visited, I saw the milker milking a suspected cow on to the ground.

388. I suppose it may be assumed that the Copenhagen system is well known, and thoroughly understood at the Board of Agriculture?—I cannot answer that question.

(*Prof. Brown.*) Yes, I think we have all the reports.

389. (*Chairman.*) It is a very interesting and important point, whether these facts are within the knowledge of the Board of Agriculture. At present I do not think we need carry it further than that there is such a system carried out in Copenhagen. (*To witness.*) Do you know anything of the matter?—I do not think the Board of Agriculture have anything beyond the Consul's reports.

(*Prof. Brown.*) We possess, I believe, all the reports which have been sent over. Possibly we may not have any private reports which have been made to or by the association itself.

390. (*Dr. Buchanan.*) Is the association a very large one?—Yes, it is a very large association, but it is entirely private. It employs a staff of about 180 people. In 1879 it supplied about 400,000 gallons of milk and cream; last year, 1889, about 1,300,000 gallons, the produce of 4,300 cows, on about 50 farms.

391. How is tuberculous milk detected?—I have said that there is a system of inspection.

392. Is the inspection vigilantly carried out?—Yes. In 1889, 153 animals were withdrawn on account of tuberculosis alone, among them three for tuberculosis of the udder; and the farmers are most anxious to supply their milk to the association, because, if their milk is cut off because it is suspected of being diseased, they still receive pay for the milk, even although it may be destroyed, until the matter is put beyond doubt. They are paid for all the milk that is sent in and thrown out of the supply. It is, therefore, a great advantage to the farmer to be allowed to supply the association, and in the event of any *lapsus* on his part, he is obliged to leave the association.

393. Then is it the case that in some instances tuberculous milk does find its way to the provincial districts of Denmark?—Most of it is destroyed when it is found to be tuberculous; but this is not compulsory.

394. (*Prof. Brown.*) Exactly the same thing is done in this country. An agreement is made with the farmer, and to a very great extent he acts in perfect good faith. Is not that so?—Yes, I should say so.

395 (*Dr. Buchanan.*) There is a question I wish to put to you in regard to the meat inspection. I have observed that the records which have been kept in connexion with the Berlin slaughter-houses or the records of the Manchester slaughter-houses show a remarkably small proportion of tuberculous meat, as compared with the number of tuberculous animals which are known to exist, perhaps covertly, throughout the kingdom. Are you aware of that fact?—Yes.

396. Does it not appear to signify that the result of a more stringent inspection in the large towns would probably be to disturb the supply of tuberculous meat, but that it would not prevent a dealer from sending

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tuberculous food to districts where the inspection was less rigid ?—I think that might be the case, and it is why, I think, the inspection should be general.

397. Then in regard to certain localities a more rigid inspection would not succeed in stamping out the disease ?—No, but it would protect the localities to a certain extent. It would not, however, be entirely effectual in preventing the spread of disease.

398. Would the same remark apply to the case of milk ?—Yes, I think so.

399. (*Prof. Burdon - Sanderson.*) Some very esteemed authorities in this country have expressed an opinion that even the healthy organs of a tuberculous animal dying from tuberculosis are a source of danger. Have you made any experiments which tend to support that view ?—I have only made experiments in the shape of inoculation, and I have made them upon animals.

400. I meant from apparently healthy meat ?—Yes, from apparently healthy meat, but from which *tubercle bacilli* have been developed.

401. The apparently healthy meat of tuberculous animals ?—Yes, I have inoculated animals with such material; for instance, with juice from the pleura and from the peritoneum taken from the under surface of the diaphragm.

402. With what result ?—Tuberculosis has been developed. I have made use of juice from the muscles under the pleura, after stripping, and also from the position above mentioned, and I have been able to produce tuberculosis, even although the organs appeared to be healthy, and to contain no tuberculous matter.

403. How many times have you obtained a result of that kind, which appeared to you to be certain ?—Five times.

404. Were the experiments always made upon rabbits ?—No, in one case it was upon a guinea pig; in the other four cases, rabbits were used.

405. Assuming that it were possible, what do you think would be the most effectual measure for preventing tuberculosis arising from meat infection. Do you think that the general enforcement of a system, such as exists in Denmark, for example, would bring about a satisfactory result, or would other measures be necessary in addition ?—I think that other measures would be necessary where there were other sources of infection.

406. Have you thought what other sources might arise ?—Do you mean human sources of infection ?

407. I am speaking more particularly in regard to infected meat at the present moment. What other sources of infection would there be in relation to meat ?—In relation to meat, in order to prevent the risk of infection, I should require the compulsory slaughter of tuberculous animals and the compulsory inspection of all animals slaughtered, whether tuberculous or not.

408. Is the compulsory slaughter of all animals suffering from tuberculosis carried out in Denmark ? —No.

409. It is not attempted ?—No.

410. That is to say, that the inspection is limited to meat intended for consumption ?—Yes, of course it is not inspected until it is brought into Copenhagen, either to be slaughtered or already prepared for consumption. The municipal veterinary surgeon may seize any animal on the market, and its value is paid to the owner out of the mutual insurance fund. But the animals killed outside the city are, as already stated, inspected at the owner's risk if the carcases are brought into Copenhagen.

410*a*. What is your experience as to the consumption of milk by the poor. Is it not the case that in towns all families use milk ?—Yes, even the very poorest use a certain quantity. I am speaking now of Edinburgh more particularly. All take some milk. In some instances it may be a very small quantity, but nevertheless all families do buy some proportion.

411. All of them buy milk ?—Yes.

412. Is it the opinion of doctors that milk is not used in sufficient quantity by the poorer class of people, or that that which is used is not of a very good quality ?—The general opinion is that it is not used in sufficient quantity, and that very frequently the quality of that which is used is bad.

413. You believe that there is a risk to the health of the poor from milk infection ?—Certainly.

414. Then that risk is universal ?—It is a risk which, if it exists, may be regarded as universal ?— It may.

415. What is the character of the education of the inspectors employed in Copenhagen ?—They are all veterinary surgeons, and usually they are selected from the very best men in the profession.

416. Then we may take it that they are well educated ?—Yes, they are very well educated indeed.

417. Have you had any relations with the veterinary inspector in Edinburgh ?—Yes.

418. Do you imagine that the somewhat less careful education of the veterinary practitioner in this country might be a difficulty ?—No, I do not think it would create a difficulty.

419. It would not in your opinion, prove a source of difficulty ?—No.

420. You do not think there would be any marked difference in regard to education ?—There would be to a certain extent.

421. In what way ?—The veterinary surgeon in this country has not devoted so much attention to this subject as the veterinary surgeon in Denmark has.

422. Are the veterinary inspectors in Copenhagen specially educated for this purpose; have they to undergo special studies and training ?—Yes. The inspector first goes as an assistant inspector, and then he is gradually promoted. I may say, however, that an ultimate decision never rests with the assistant inspectors. If meat is suspected by the assistant inspector he does not condemn it and order it to be destroyed; that duty is always left to the head inspector.

423. The head inspector is called upon to act in all doubtful cases ?—Yes.

424. The chief or head inspector ?—Yes.

425. I presume that there is a large staff ?—Yes.

426. Is it much larger than that which exists in Edinburgh ?—Yes, so far as skilled men are concerned. There are a considerable number of persons employed in Edinburgh, but they are not regularly qualified veterinary surgeons. I do not think there is one.

427. Not one ?—No, I think not. The only one, I believe, is a market inspector.

428. So that in order to carry out here the system which exists in Denmark it would be absolutely necessary, in addition to other points, that there should be a considerable staff of veterinary inspectors ? Yes, a considerable staff.

429. In order that the inspection might be carried out efficiently ?—Yes.

430. As regards the question of heredity, I think we must get rid of terminology. Your view seems to be that in very numerous cases in which tuberculosis may be inherited, the inheritance is not of the disease, but of a predisposition to it ?—Yes, that is my view.

431. As regards the practical result, does it not come to the same thing ?—It may; but my opinion is that if the child were kept under better conditions the probability is that he would not develop tuberculosis, and the number of the more direct cases—cases in which the disease is said to have been inherited—would be very considerably diminished. I do not think that disease actually exists, but there may be a predisposition to take it.

432. Then may I take it that, in your opinion, in the majority of cases of tuberculosis in human beings the disease is transmitted by some sort of hereditary predisposition ?—No, because I think that a predisposition may also be acquired.

433. Do you think that in the majority of cases tuberculosis is acquired by external infection?—Yes, most certainly.

434. Of healthy persons?—Yes, of healthy persons, but persons who are either temporarily unhealthy or of a weak constitution. In the latter case the weakness may be hereditary; this would render the patient more susceptible to the action of external agents.

435. Do you admit that in the majority of cases the reason why such and such a person acquires tuberculosis is that he has had transmitted to him from the parents something or other that makes him more liable than other people to contract the disease?—Yes, but the actual disease is contracted after birth. I should only regard most acquired predispositions as something temporary, and the actual disease as something contracted from external agencies.

436. That is not the point I want to get out. I want to know what you think as to the actual circumstances which have led to the development of tuberculosis. I want to learn from you what has actually occurred when an individual shows signs of having become infected with tuberculosis. You admit that there may be a predisposition in the child?—Yes, I say that that may be one of the factors.

437. The question is whether it is the factor in the greatest number of cases?—No, I should say not.

438. You think that external infection is the exclusive factor in the greatest number of cases?—That it is the greatest factor.

439. (*Chairman.*) I understood you to say something stronger than that, namely, that external infection is the exclusive factor in all cases?—No, but I think it is the largest or exciting factor in all cases.

440. (*Prof. Burdon Sanderson.*) That is not the point which I am dealing with at present. Do you think the cases in which external infection is the exclusive cause of a person acquiring tuberculosis form the majority of cases, or only the small minority?—I stated distinctly that unless the constitution of the patient has become weakened in some way, the risk of external infection taking effect is very small.

441. In what proportion of cases of tuberculosis can it be stated that the exclusive cause of the disease is infection from without?—That is a question which I can scarcely answer.

442. (*Chairman.*) I thought you said it was the main instrument and cause?—Yes, no case of tuberculosis occurs without that factor.

443. But there may be a number of other factors?—Yes.

444. Such as a predisposition?—Yes.

445. That is a totally different thing. If your doctrine is correct, consumption in individuals or in mankind may be stamped out in the course of time by a process of examination and restriction?—Yes, I think that that is theoretically possible.

446. (*Prof. Burdon Sanderson.*) I do not think you have quite answered my point yet?—I do not exactly see how I can answer your point more fully or in a different way.

447. I want to know whether, generally speaking, in your opinion, it is the case that the acquirement of tuberculosis by a healthy person is exclusively the result of external infection?—I do not think, as I have said before, that a healthy person ever does acquire tuberculosis.

448. You do not think that a healthy person ever acquires it?—No.

449. Then it is hereditary?—Not so.

450. Evidently it must be so?—I do not think so. There may be temporary changes in the alimentary tract, in the lungs, and so on, not necessarily inherited, and if the tubercular *bacilli* find an entrance under such circumstances, tuberculosis is set up owing to the weakened condition of the patient, but it could not be set up without the action of an external cause.

451. Then you consider that there are two ways in which a person may acquire a predisposition towards tuberculosis; in the first place it may be inherited?—Yes.

452. And, secondly, it may be acquired from external influenes, owing to the existence of previous disease?—Yes, from a previously weakened condition of the tissues.

453. That is to say, from a previous ailment?—Yes; although it may not necessarily be what one would call disease, it might arise from a slightly altered condition of the patient's state of health, not amounting to actual disease. Tuberculosis may also, as I have mentioned, be congenital.

454. What do you mean by congenital tuberculosis?—I should call it congenital tuberculosis where it was found that tuberculosis was actually in existence at the time the child was born.

455. That is to say, that symptoms of the existence might be found at the time of birth?—Yes.

456. You say that cases of that sort are exceedingly rare?—Yes, very rare; but cases have been recorded.

457. Can you give us any information as to the development of tuberculosis in calves, because it is a most remarkable fact, and one which has been already spoken of, that calves are wonderfully free from tuberculosis. What is known as to the time the disease takes to develop itself in a calf?—It usually makes its appearance some months after birth.

458. In what form?—Very frequently in the intestinal glands.

459. (*Prof. Brown.*) Have you had any opportunity of studying the matter?—I have seen several cases, but I have not had an opportunity of seeing many.

460. You do not mean that you made experiments in regard to them?—No.

461. (*Prof. Burdon Sanderson.*) I wish to put a question to you on feeding. Are you aware of any feeding experiments in reference to calves?—I believe there have been a number of experiments made. I have not got the exact number, but I know that there have been a number of feeding experiments in connexion with calves.

462. Has the result of any of the experiments shown that the development of the disease is very slow or very rapid?—It usually takes place within about three months.

463. Is it possible that the reason why one does not observe tuberculosis in young calves is that the animals are killed too young?—I cannot answer that question.

464. You do not know?—No, not more fully than I have already stated.

465. (*Prof. Brown.*) Now, in reference to milk, Dr. Woodhead, did I understand you to say that the children of poor persons are more liable to tuberculosis than the children of well-to-do people?—My experience has been entirely among the poorer people, but, as a matter of fact, I think they are more liable to be infected with tuberculosis than the children of the wealthier classes.

466. Then it is the case?—Yes, I think so.

467. Is there any particular reason that occurs to you why poor children should be more likely to get tuberculous milk than the children of the rich?—No, not in this country, except that the cows which supply poor people with milk may be kept in the cow-houses under rather worse conditions than those which supply the rich.

468. For example, is it likely that they might be cows of a poorer quality?—I should think that is very likely.

469. Do tuberculous cows give a diminished supply of milk compared with those which are not infected?—No, I think it is rather the other way.

470. They give more?—I believe so, at certain stages of the disease.

471. Then it might be possible, for a small sum that a dairyman would be able to purchase a cow which would give a lot of milk, but there would be all the more fear that it was in a tuberculous condition?—Yes, in some stages of the disease.

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472. If a tuberculous cow were wanted, would a dairyman have any difficulty in finding it in a poor neighbourhood?—Our experience was that some were to be found in poor neighbourhoods, while others certainly were to be found in a very well-to-do locality.

473. Were your experiments made by feeding with meat juice?—By inoculating with meat juice.

474. Did you find out that the meat juice was free from *tubercle bacilli*?—We could not get evidence of the *bacilli*.

475. You could not detect them?—No; that was the reason we tried inoculation. The experiments we made were not feeding experiments, and it was because we did not find the *bacilli* that we tried inoculation. We found the *bacilli* in some of the organs in very large quantities.

476. In the case of the pleura is there not a great probability of infection with active *bacilli* in trying to clear it?—Yes.

477. Those parts are generally trimmed by the butcher which would show that there was infection?—Yes; the meat I saw had been trimmed by the butchers.

478. You spoke about meat inspection, and you have made some rather important suggestions in regard to which I wish to ask a few questions. You have recommended a very general inspection of the meat, and if that should be brought about as the result of your evidence, it would fall to the lot of my department to pass an order for that purpose. I will ask you, in the first place, do you think there would be any difficulty in this country in carrying a system of this kind into effect?—Probably there might be some difficulty at first.

479. For example, are you aware that in London alone there are several hundred slaughter-houses? I do not know the actual number, but it is very large?—No, I was not aware of that fact.

480. Many of them are little places behind the butchers' shops in narrow courts and lanes. Are you aware that in such places cattle, sheep, and swine are slaughtered?—No, I was not aware of that fact, and I do not think such a state of matters should be allowed.

481. But admitting it to be the case, would not a system of inspecting the slaughter-houses regularly, which must be done, if we are to do what you suggest, involve a very large amount of arduous work?—Yes, no doubt.

482. And also involve a great deal of expense?—Certainly; but in Copenhagen the public slaughter-houses, &c. pay their own expenses. A deficit has not been known since they were erected, and the control system was instituted. Should a deficit occur, the municipal authorities would be called upon to make it good. The principal income is derived from charges made for the inspection of carcases at the control or inspection stations, sale of manure, and gate money taken at the cattle market adjoining, and belonging to the public abbattoirs.

483. And the employment of a considerable number of men?—Yes.

484. You think that in every case a skilled inspector ought to be employed?—Yes, I think that if the butchers and the people are to have any confidence in the results of the inspection, the inspectors employed should be skilled men.

485. Of course that would involve considerable expense?—Yes.

486. In each case?—Yes.

487. Do you think from what you saw in Copenhagen that all the veterinary surgeons there are competent to detect tuberculous deposit?—Yes, I certainly think the head inspector is most competent, and it is he who has to decide.

488. They are, in your opinion, able to detect that a deposit in the pleura or in the pericardium is due to tuberculosis?—Yes, I have no doubt they are.

489. Does that remark apply to all of the inspectors, or to the head inspector only?—If there is any doubt at all the head inspector is called in to decide.

490. Can you, from your own knowledge, say whether it is difficult or not to detect whether a deposit contains *tubercle bacilli*, or is actually tuberculous?—There may be considerable doubt at first, but it can be proved in the course of a few minutes.

491. In any case of doubt or difficulty in Copenhagen the head inspector is called in?—Yes.

492. Have they more than one slaughter-house in Copenhagen?—No, only one.

(*Prof. Brown.*) I think that is a question which ought to be brought out prominently. It must reduce the difficulty of the matter very much.

493. (*Chairman.*) What is the population of Copenhagen?—About 310,000, I think. The adjoining town or suburb of Frederittsberg, which, however, is not included in the municipal boundaries, has a further population of about 50,000.

494. (*Prof. Brown.*) As to the inspection of the carcase, I take it that we should be bound for the purpose of carrying out your proposition to inspect all the foreign meat sent into this country?—Yes, all the meat going into town or country would have to be inspected.

495. May I give you an idea of what that would involve? 300,000 animals are landed in this country from the United States alone, all of which have been previously slaughtered and dressed. It would be necessary to examine at the different ports every week something like 6,000 carcases, and that would form only an infinitesimal part of the meat supply which the inspector would have to examine in this country. It only touches one country, and does not deal with the whole of the meat which is brought in in the shape of carcases. Would not the inspection in such a case involve very great expense, labour, and difficulty?—No doubt; but it might be done more easily here and at less expense than in a small isolated city like Copenhagen.

496. Do you mean by centralizing the movement of the carcases to a particular port or place for inspection?—Yes.

497. Would it not involve an enormous delay?—No, I think not. The carcases could be brought in at the railway stations or docks, and the whole inspection could be managed most expeditiously.

498. Carcases landed from foreign countries are already examined at nearly every port to which they are sent, but I understand you to ask for some kind of central inspection?—Each of the ports would be a centre in connexion with the town in which in all probability the meat would be consumed or from which it must be sent on. It could pass through the hands of the inspectors at the ports and railway stations.

499. The carcases generally come over packed and covered with canvas. Do you propose that the carcases should be unpacked and inspected before they are allowed to be moved to any other part of the country to which the consumer may desire to have them sent?—It must be inspected whether the inspection is done at the port or some other inspection station most convenient for the consumer.

500. What kind of inspection would you have?—The same as that which is carried out in Copenhagen.

501. Is it a microscopic inspection?—Yes, if necessary.

502. That would have to be done if one boat brought 4,000 carcases and another 2,000 more?—Yes, an expert ought first to examine the meat with the naked eye and say whether it presented appearances which rendered it desirable that it should be further examined or not. Such further examination would only be necessary in those cases in which doubt might arise.

503. Would you only examine one or two carcases out of a cargo?—An examination would only be necessary in those cases in which there was any suspicion of disease; I mean a strict examination. Of course the whole of the meat would have to be examined.

504. The whole number of carcases brought over and landed?—Yes, but in every case it would not be necessary that the examination should be microscopical.

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505. Have you formed any opinion as to the time at which the cargoes would be brought in?—No, I know nothing of that.

506. Are you aware that they may be brought into a port at 7 or 8 or 9 o'clock at night, and that they are immediately landed, transferred to the railway trucks, and sent off to the meat market?—Even in that case if they are not unpacked at once they can be inspected at the centres from which they are sent: to the London meat market or to the Liverpool or Manchester meat markets.

507. But, for example, the carcases brought over might be consigned to some 20 or 30 different persons in various parts of South Wales. Would you in that case require them all to be taken to one place to be inspected?—I think it would be necessary to provide that they should go to some place for the purpose of being inspected.

508. If the place of inspection happened to be beyond the railway system, would you require them to be carted to the point at which the inspection was to be made?—These are all merely practical details. I should feel inclined to say that the place of inspection should be in connexion with the railway or shipping centre to which they are taken before being distributed, but no meat should be allowed to be retailed until it is stamped.

509. You quite realise that it would be extremely difficult to carry out the regulations you would impose?—I quite realise that if such provisions were laid down it might take some time to get them into working order.

510. Would not the whole of the meat trade be opposed to them?—That would probably be the case at first.

511. And the result would be a large addition to the duties of the Minister of Agriculture?—Yes, no doubt that was the case, I believe, in Copenhagen at first. There was originally a good deal of opposition, but it entirely subsided, and ultimately all classes became willing to submit to the regulations.

512. I understand you to say that the system applies only to Copenhagen and not to the whole of Denmark?—It applies only to meat passing into Copenhagen or through it. I do not know what is done in the provinces. I only studied the system in Copenhagen.

513. Are you of opinion that although there might be considerable opposition in this country on the part of the meat trade to similar regulations here, that in the end they would be submitted to?—Yes. I think so; they might even be welcomed, as they were in Copenhagen. In any case the present state of uncertainty would be avoided by the butchers and cattle dealers, a change that would, I think, be welcomed by them. The stamping would increase the value of the meat to the retailer.

514. Is it the case that animals and carcases are brought into Copenhagen from the districts outside?—Yes, they are brought in from the outside.

515. Are the animals slaughtered outside before they are brought in?—Yes, some of them.

516. And the whole of them are inspected?—Yes.

517. They are compelled to be taken to a central station?—Yes.

518. (*Chairman.*) Is that after the meat has been dressed?—Yes.

519. I presume you appreciate the fact that in regard to the animals which are brought to this country from abroad they are dressed carcases from which any portion which might indicate the presence of tuberculosis will have been removed?—If the parts which would indicate the presence of tuberculosis were removed, the inspector would always take notice of the fact.

520. As a matter of fact, are you able to say whether in regard to carcases coming from abroad they have not been prepared for consumption before they are sent away, and whether all the parts which would show infection have not been removed?—That is so, but an inspector would tell at once whether a particular part had been removed for the purpose of preventing the detection of tuberculosis.

521. (*Prof. Brown.*) That would be quite easy, I think?—Yes.

522. (*Prof. Burdon Sanderson.*) Are there two systems of inspection in force at Copenhagen, namely, in the abattoir in addition to the inspection which the meat would undergo on its arrival at the port, or only one?—In such a case the meat would be inspected twice, unless it was stamped at the first inspection, which it could not be if the animal was alive. Many of the cattle, as I have mentioned, are condemned during life by the municipal inspecting veterinary surgeon.

523. It would also be inspected at the railway station when it arrives there?—Yes, it would undergo a regular inspection in both cases; but every inspection is carried on in the same way.

524. Under the same regulations in regard to the inspection?—Yes.

525. Do you think it would be possible to calculate or to obtain the data for calculating the actual expense of the inspection per head of cattle?—I think it would be perfectly easy to obtain that information from the statistics already kept. Of course all the statistics are kept.

526. It would be comparatively easy to get at the facts?—Yes, I think so. In Copenhagen it is, as I have said, self supporting.

527. Because I suppose that however large the work to be done in this country would be as compared with Copenhagen and Denmark, the proportion of the relative expense of the inspection would be no greater here than in Denmark?—Probably it would be less, because the animals would be dealt with in larger numbers.

528. (*Chairman.*) I have only one or two further questions to ask. Do I understand you to say that, in your opinion, by the adoption of proper regulations, tuberculous disease, both in animals and mankind, in this country might be entirely stamped out?—Yes, theoretically it might.

529. The tuberculous disease we have here, which is known as consumption in grown-up persons and *tabes mesenterica* in children?—Yes.

530. Through the adoption of the very stringent system you recommend, both as regards milk and meat?—Yes, and by attacking other sources of infection.

531. Although the system has been in operation for five years in Copenhagen, which is a town of 300,000 inhabitants, there are no quotable statistics to show that the condition of the people has improved?—I can scarcely say that there are no quotable statistics.

532. Then, as far as you know, there are statistics?—Yes; the authorities of Copenhagen are, I believe, preparing statistics at this moment, and they are convinced that the result will be found to be favourable.

533. You say that the disease known as consumption which afflicts mankind is not hereditary?—That is my view.

534. But is contracted by weakly and delicate children from outside influences?—Yes.

535. And that the disease is not necessarily contracted by eating infected meat?—That is my opinion.

536. (*Prof. Brown.*) What system would you suggest for adoption in order to detect the existence of tuberculosis in a living animal?—By paying special attention to the condition of the glands in the neck, and those in front of the haunch bones, which should always be equal in size, the state of the alimentary canal, and the general condition of the animal, as regards coat and skin, especially over the flanks, the lungs should be examined by auscultation and percussion, before and after the animal coughs, which it should be made to do by slight compression of the trachea. The glands above the hinder quarters of the udder, and the quarters themselves, should always be most carefully examined for enlargement and hardness, especially when tenderness is present. An examination should also be made per rectum with the object of

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determining whether there is any tubercle of the peritoneum. The mucus in the throat should also be examined.

537. Is it easy to detect *bacilli* in mucus in the throat?—Yes. The mucus is removed with a sponge or with a piece of cloth; it is then stained on a cover glass by the ordinary method, and examined microscopically.

The witness withdrew.

STATISTICS supplied to Dr. WOODHEAD by Prof. BANG, Dr. RASSMUSSEN, Mr. BUSCH, and Mr. CARL SPRENSEN, in answer to Question 346.

1888.

There were slaughtered in the public slaughter-houses in Copenhagen—

Cattle, 34,196, of which 5,568, or 16·28 per cent., were tuberculous.

Calves, 49,477, of which 57, or 0·12 per cent., were tuberculous.

Pigs, 8,569, of which 975, or 11·38 per cent., were tuberculous.

There were slaughtered outside the city, but inspected at the Copenhagen Control Stations—

Cattle, 6,099 quarters, of which 369, or 6·5 per cent., were stamped 2nd class, as coming from tuberculous animals.

Calves, 7,442 half-carcases, of which 8, or ·11 per cent., were stamped 2nd class, as coming from tuberculous animals.

Pigs, 417,210 half-carcases, of which 4,489, or 1·07 per cent., were stamped 2nd class, as coming from tuberculous animals.

Condemned completely—
Cattle, 1,286 Danish pounds.
Pigs, 13,772 Danish pounds. 100 Danish pounds = 1 cwt.

Average weight of cattle, say, 380 Danish pounds.
,, ,, calves, ,, ? ,,
,, ,, pigs, ,, 150 ,,
,, ,, horses, ,, 536 ,,
,, ,, sheep, ,, 25 ,,

1889.

There were SLAUGHTERED and INSPECTED in the Copenhagen Abattoirs.

Quarter.	Kind.	Numbers Killed.	Stamped 2nd Class* for Tubercle.	Confiscated in Lbs. for Tubercle.	Organs condemned for Tubercle.
January to March	Cattle	8,298	388	15,595½	3,161.
	Horses	136	—	—	
	Pigs	635	97	1,186½	
	Calves	10,853	8¾	133½	
	Sheep	667	—	—	
April to June	Cattle	6,806	319¼	13,995½	2,714.
	Horses	95	—	—	
	Pigs	1,037	109¾	1,210	
	Calves	14,869	16¾	107	
	Sheep	24,772	—	—	
July to September	Cattle	7,105	354¾	20,462	2,808.
	Horses	122	--	536	
	Pigs	928	55¾	361	
	Calves	11,566	24½	102	
	Sheep	47,386	—	—	
October to December	Cattle	8,630	316½	20,940	2,915.
	Horses	272	—	—	
	Pigs	513	91	851	
	Calves	10,982	14	264	
	Sheep	5,033	—	25	
	TOTALS FOR YEAR.				
	Cattle	30,839	1,378½	70,993	
	Horses	625	—	536	
	Pigs	3,113	353½	3,608½	
	Calves	48,270	64	606½	
	Sheep	77,858	—	25	

* *i.e.*, not exactly unfit for human food, but the animal has suffered from localised tuberculosis. The 2nd class stamp indicates that the meat ought to be very well cooked; it corresponds to that meat which is sold in southern Germany, called the Freibank.

The number of animals brought to the Cattle Yard for sale in 1889 was—

Cattle	55,336
Horses	1,716
Pigs	1,368
Calves	39,877
Sheep	?
Geese	2,758

The owners of all these animals have to pay the entrance fee at the gate, although they are not to be slaughtered. They also pay the insurance fee to the gate keeper.

1889.

There were SLAUGHTERED outside the City but inspected at the Copenhagen Control Stations.

Quarter.	Kind.	Numbers Examined.	Stamped 2nd Class for Tubercle.	Confiscated in Lbs. for Tubercle.	Organs condemned for Tubercle.
January to March	Oxen	1,771/4	84/4	641	36.
	Horses	2,050/4	—	—	
	Swine	118,972/2	1,880/2	5,202¾	
	Calves	1,861/2	2/2	—	
	Sheep	3/1	—	—.	
April to June	Oxen	1,472/4	77/4	349	38.
	Horses	1,775/4	—	—	
	Swine	76,184/2	1,075/2	4,706	
	Calves	3,408/2	—	—	
	Sheep	1,516/1	—	—	
July to September	Oxen	1,610/4	62/4	540	55.
	Horses	1,947/4	—	—	
	Swine	52,343/2	350/2	1,066½	
	Calves	2,292/2	—	—	
	Sheep	3,776/1	—	—	
October to December	Oxen	2,059/4	65/4	78	37.
	Horses	2,079/4	—	—	
	Swine	99,318/2	1,474/2	4,447	
	Calves	2,722/2	—	—	
	Sheep	465/1	—	—	

Large animals are brought in in quarters, thus, 1,771/4 = 1,771 quarters.
Small „ „ half-carcases, thus, 1,861/2 = 1,861 halves; 3/1, 3 carcases of sheep, for example.

1890.

In the Quarter, January—March, there were SLAUGHTERED in the Copenhagen Abattoir 8,620 Oxen, 212 Horses, 563 Swine, 11,474 Calves, 1,056 Sheep.

—	Stamped 2nd Class.					Entirely Confiscated.					Part of Carcase Confiscated.					Pounds Condemned.	Organs Condemned.
	Oxen.	Horses.	Swine.	Calves.	Sheep.	Oxen.	Horses.	Swine.	Calves.	Sheep.	Oxen.	Horses.	Swine.	Calves.	Sheep.		
For tubercle	463	1	97¼	14½	–	39	–	–	1	–	154	–	61	8	–	26,105	3,892
Percentage	5·37	·47	17	·12	–	·45	–	–	·009	–	1·8	–	1·83	·7	–	–	–

In the Quarter, January—March, there were SLAUGHTERED outside the City but inspected at the Copenhagen Control Station 1,934/4 Oxen, 1,996/4 Horses, 98,501/2 Swine, 2,821/2 Calves, 33/1 Sheep.

—	Stamped 2nd Class.					Entirely Confiscated.					Part of Carcase Confiscated.					Pounds Condemned.	Organs Condemned.
	Oxen.	Horses.	Swine.	Calves.	Sheep.	Oxen.	Horses.	Swine.	Calves.	Sheep.	Oxen.	Horses.	Swine.	Calves.	Sheep.		
For tubercle	94/4	–	1,608/2	–	–	1	–	28	–	–	–	–	210	–	–	5,745	30
Percentage	4·86	–	1·6	–	–	·2	–	·11	–	–	–	–	·85	–	–	–	–

STATISTICS of TUBERCULOSIS in the Human Subject in Copenhagen for the Years 1888–1889.

Population of Copenhagen in 1889, 308,600.

	1888.	1889.
Deaths from phthisis pulmonum	808	766
Tuberculosis acuta	61	75
Tuberculosis in other organs of the body, excluding hydrocephalus	80	56
Hydrocephalus acutus	?	130

	1888.	1889.
Atrophia infantilis, some of which are probably tubercular	?	334

Excluding the last two groups the totals were for 1888, 949, and in 1889, in spite of increase of population, only 897.

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The following statistical returns have come to hand since the foregoing was printed :—

POPULATION of COPENHAGEN—(The whole Town, including the Roadstead and Port.)

1883	268,400	1888	303,500
1884	274,000	1889	312,387
1885	284,000	1890	312,859
1886	289,500	1891	323,000
1887	295,000	1892	330,000

NOTE.—In the mortality returns are included people brought in from outside districts who die in the hospitals.

RETURNS of MORTALITY from TUBERCULOSIS in COPENHAGEN, classified according to Times of Year.

NOTE.—In the mortality returns are included people brought in from outside districts who die in the hospitals.

——	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
							1883.						
Scrophulosis - - -	–	3	3	–	1	–	3	1	–	2	1	–	14
Hydrocephalus acutus -	1	–	2	1	1	1	1	–	–	–	1	–	8
Tuberculosis acuta - -	3	7	7	4	6	2	5	7	1	1	1	2	46
Phthisis pulmonum -	61	69	79	76	64	51	51	45	45	51	43	64	699
Tuberculosis in aliis corporis partibus.	10	15	8	17	17	14	11	10	14	5	14	9	144
Total -	–	–	–	–	–	–	–	–	–	–	–	–	911
							1884.						
Scrophulosis - - -	2	2	2	1	2	2	3	–	–	2	–	2	18
Hydrocephalus acutus -	5	11	21	8	12	9	6	8	10	4	7	13	114
Tuberculosis acuta - -	4	4	5	8	6	4	5	6	6	5	2	3	58
Phthisis pulmonum - -	58	67	61	60	66	74	74	39	51	69	54	77	750
Tuberculosis in aliis corporis partibus.	7	6	4	10	8	6	7	10	7	6	6	7	84
Total -	–	–	–	–	–	–	–	–	-	–	–	–	1,024
							1885.						
Scrophulosis - - -	–	2	1	1	1	2	–	–	1	–	1	1	10
Hydrocephalus acutus -	8	9	10	12	8	10	9	8	8	7	11	12	112
Tuberculosis acuta - -	5	5	6	5	2	1	2	3	2	2	–	5	38
Phthisis pulmonum - -	64	62	72	74	55	65	52	47	46	42	60	66	705
Tuberculosis in aliis corporis partibus.	10	10	10	10	13	6	6	3	10	4	5	7	94
Total -	–	–	–	–	–	–	–	–	–	–	–	-	959
							1886.						
Scrophulosis - - -	–	–	1	1	1	1	2	2	–	–	1	1	10
Hydrocephalus acutus -	14	11	16	17	22	9	7	12	6	7	10	6	137
Tuberculosis acuta - -	2	3	7	4	9	4	5	3	8	7	4	6	62
Phthisis pulmonalis -	68	44	53	76	61	45	56	43	46	53	60	48	653
Tuberculosis in aliis corporis partibus.	9	4	8	6	13	8	7	4	6	6	3	5	79
Total -	–	–	–	–	–	–	–	–	–	–	–	–	941
							1887.						
Scrophulosis - - -	–	1	–	1	1	1	2	1	–	3	1	–	11
Hydrocephalus acutus -	10	7	5	12	9	7	9	4	7	10	8	10	98
Tuberculosis acuta - -	4	9	2	3	3	7	3	7	1	1	4	5	49
Phthisis pulmonalis - -	76	73	79	60	62	62	62	50	57	54	58	61	754
Tuberculosis in aliis corporis partibus.	1	3	4	8	3	8	6	5	2	5	3	5	53
Total -	–	–	–	–	–	–	–	–	–	–	–	–	965
							1888.						
Scrophulosis - - -	1	–	3	2	1	1	–	–	2	1	1	1	13
Hydrocephalus acutus -	14	7	14	16	13	11	16	6	4	6	14	11	132
Tuberculosis acuta - -	7	6	4	8	6	4	5	2	2	8	4	5	61
Phthisis pulmonalis - -	67	66	86	80	85	75	53	58	50	68	57	63	808
Tuberculosis in aliis corporis partibus.	3	12	9	10	12	8	5	5	6	5	4	1	80
Total -	–	–	–	–	–	–	–	–	–	–	–	–	1,094

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Returns of Mortality from Tuberculosis in Copenhagen, &c.—*continued.*

——	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1889.													
Scrophulosis - - -	–	–	–	–	–	–	–	3	–	–	–	1	4
Hydrocephalus acutus -	14	11	9	8	12	11	18	7	10	12	11	7	130
Tuberculosis acuta - -	5	3	10	11	9	2	6	5	11	3	7	3	75
Phthisis pulmonalis - -	65	61	66	68	78	70	69	52	56	53	47	81	766
Tuberculosis in aliis corporis partibus.	4	3	6	9	7	2	5	7	4	1	3	5	56
Total -	–	–	–	–	–	–	–	–	–	–	–	–	1,031
1890.													
Scrophulosis - - -	1	–	1	1	2	–	–	2	–	1	–	–	8
Hydrocelphalus acutus -	10	11	14	14	11	8	14	2	4	11	7	12	118
Tuberculosis acuta - -	4	9	15	9	12	7	5	6	3	5	9	2	86
Phthisis pulmonum - -	86	66	63	59	66	62	62	57	53	53	65	43	735
Tuberculosis in aliis corporis partibus.	1	9	7	6	5	2	4	9	7	7	5	4	66
Total -	–	–	–	–	–	–	–	–	–	–	–	–	1,013
1891.													
Scrophulosis - - -	–	1	–	1	1	1	2	1	–	–	–	-	7
Hydrocephalus acutus -	5	12	16	20	11	14	13	11	8	8	15	8	141
Tuberculosis acuta - -	5	2	4	8	14	12	11	4	3	5	2	6	76
Phtbisis pulmonum - -	57	59	79	74	72	65	42	36	29	45	54	68	680
Tuberculosis in aliis corporis partibus.	3	5	5	10	5	8	7	6	2	4	5	11	71
Total -	–	–	–	–	–	–	–	–	–	–	–	–	975
1892.													
Scrophulosis - - -	–	–	–	1	–	–	–	–	–	–	–	–	1
Hydrocepbalus acutus -	6	15	22	9	16	17	9	15	9	13	8	13	152
Tuberculosis acuta - -	5	12	5	6	9	3	10	5	5	8	5	9	82
Phthisis pulmonum -	58	75	59	60	67	50	34	35	53	41	53	49	634
Tuberculosis in aliis corporis partibus.	3	6	9	7	5	9	11	3	7	4	2	5	71
Total -	–	–	–	–	–	–	–	–	–	–	–	–	940
Total mortality from Tuberculosis in - 1883	75	94	99	98	89	68	71	63	60	59	60	75	911
„ „ - 1884	76	90	93	87	94	95	95	63	74	86	69	102	1,024
„ „ - 1885	87	88	99	102	79	84	69	61	67	55	77	91	959
„ „ - 1886	93	62	85	104	106	67	77	64	66	73	78	66	941
„ „ - 1887	91	93	90	84	78	85	82	67	67	73	74	81	965
„ „ - 1888	92	91	116	116	117	99	79	71	64	88	80	81	1,094
„ „ - 1889	88	78	91	96	106	85	98	74	81	69	68	97	1,031
„ „ - 1890	102	95	100	89	96	79	85	76	67	77	86	61	1,013
„ „ - 1891	70	79	104	113	103	100	75	58	42	62	76	93	975
„ „ · 1892	72	108	95	83	97	79	64	58	74	66	68	76	940

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RETURNS of MORTALITY from TUBERCULOSIS in COPENHAGEN, according to AGE and SEX of PATIENTS.

NOTE.—In the mortality returns are included people brought in from outside districts, who die in the hospitals.

	1st Year.		2nd Year.		3rd Year.		4th Year.		5th Year.		5–10 Years.		10–15 Years.		15–20 Years.		20–25 Years.		25–35 Years.		35–45 Years.		45–55 Years.		55–65 Years.		65–75 Years.		75–85 Years.		Over 85 Years.		Age Unknown.		Total of all Ages.		
	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	Both Sexes.
1883.																																					
Scrophulosis - -	2	–	3	–	3	–	–	2	2	–	–	–	1	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	11	3	14
Hydrocephalus acutus -	3	1	1	1	–	1	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	5	3	8
Tuberculosis acuta - -	1	3	3	1	1	1	2	4	2	2	4	1	1	–	2	2	2	2	3	1	3	1	2	1	–	–	–	1	–	–	–	–	–	–	26	20	46
Phthisis pulmonum - -	7	4	2	7	5	3	1	5	–	2	5	8	5	14	18	18	42	33	87	75	67	60	64	32	43	28	31	21	8	4	–	–	–	–	385	314	699
Tuberculosis in aliis corp. partibus.	13	6	10	8	9	13	5	5	2	5	13	7	6	1	3	1	3	2	8	4	7	–	3	–	5	–	1	1	1	–	1	1	–	–	90	54	144
Total - -	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	911
1884.																																					
Scrophulosis - -	3	2	2	1	1	–	–	1	1	1	1	1	1	2	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	9	9	18
Hydrocephalus acutus -	8	13	11	13	9	11	5	5	4	8	11	6	1	2	–	1	1	–	3	1	–	1	–	–	–	–	–	–	–	–	–	–	–	–	53	61	114
Tuberculosis acuta - -	3	5	3	6	3	2	3	1	1	2	2	–	–	2	1	2	1	–	3	3	2	3	7	–	2	–	1	–	–	–	–	–	–	–	32	26	58
Phthisis pulmonum - -	5	9	7	8	3	7	1	5	2	5	5	12	3	14	19	26	29	33	90	102	63	59	69	40	46	37	15	26	5	5	–	–	–	–	362	388	750
Tuberculosis in aliis corp. partibus.	4	4	5	3	1	2	1	2	2	2	2	4	4	1	2	3	5	2	5	2	3	3	5	3	4	2	1	2	2	3	–	–	–	–	46	38	84
Total - -	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1,024
1885.																																					
Scrophulosis - -	3	1	2	–	–	–	–	–	1	1	2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	8	2	10
Hydrocephalus acutus -	14	9	10	5	10	8	7	10	4	4	12	10	–	1	–	1	1	4	2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	60	52	112
Tuberculosis acuta - -	9	3	3	3	1	1	2	1	–	1	1	1	–	–	3	2	2	–	1	–	–	–	2	1	–	–	1	–	–	–	–	–	–	–	25	13	38
Phthisis pulmonum - -	7	5	7	7	2	3	7	–	2	1	4	11	8	8	19	20	30	33	90	85	75	55	56	36	50	33	20	21	–	10	–	–	–	–	377	328	705
Tuberculosis in aliis corp. partibus.	8	5	3	3	2	2	6	–	1	3	3	4	2	2	3	3	4	4	6	7	3	4	6	1	3	2	1	2	–	1	–	–	–	–	51	43	94
Total - -	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	959
1886.																																					
Scrophulosis - - -	2	1	1	1	–	–	–	–	1	–	–	2	–	1	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	5	5	10
Hydrocephalus acutus -	14	17	16	10	9	7	9	3	6	7	15	15	–	1	1	–	1	–	2	1	2	–	–	–	–	–	–	–	1	–	–	–	–	–	76	61	137
Tuberculosis acuta - -	14	11	3	4	–	3	–	–	3	–	6	3	–	–	1	3	1	2	1	2	–	1	1	–	1	–	–	–	–	–	–	–	1	–	32	29	61*
Phthisis pulmonum - -	5	3	4	1	–	4	2	1	1	1	5	8	8	10	14	25	25	29	78	85	75	63	52	29	45	31	19	23	3	4	–	–	–	–	336	317	653
Tuberculosis in aliis corp. partibus.	3	4	5	–	2	1	2	–	1	–	8	6	3	5	5	1	3	2	2	4	6	–	2	2	6	4	1	1	–	–	–	–	–	–	49	30	79
Total - -	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	940†

* This is 62 in the other Table.

† Discrepancy of one here as compared with other Table.

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NOTE.—In the mortality returns are included people brought in from outside districts, who die in the hospitals.

	1st Year.		2nd Year.		3rd Year.		4th Year.		5th Year.		5–10 Years.		10–15 Years.		15–20 Years.		20–25 Years.		25–35 Years.		35–45 Years.		45–55 Years.		55–65 Years.		65–75 Years.		75–85 Years.		Over 85 Years.		Age Unknown.		Total of all Sexes.		
	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	Both Sexes.
																	1887.																				
Scrophulosis	1	2	1	–	–	1	–	2	–	–	2	1	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	5	6	11
Hydrocephalus acutus	11	8	6	8	6	6	2	7	5	7	14	7	2	3	–	1	2	–	1	–	1	–	1	–	–	–	–	–	–	–	–	–	–	–	51	47	98
Tuberculosis acuta	7	4	1	–	3	6	–	–	1	3	3	1	–	3	2	1	2	1	2	2	1	2	1	1	1	1	–	–	–	–	–	–	–	–	24	25	49
Phthisis pulmonum	9	6	6	4	5	6	8	9	2	2	5	13	7	10	14	15	38	29	89	95	91	55	70	37	44	27	19	27	3	6	1	2	–	–	411	343	754
Tuberculosis in aliis corp. partibus.	2	1	4	3	3	3	2	1	1	–	3	5	3	2	1	–	2	1	2	4	2	–	3	1	3	–	–	1	–	–	–	–	–	–	31	22	53
Total	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	965
																	1888.																				
Scrophulosis	4	2	–	1	1	–	–	–	–	–	4	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	9	4	13
Hydrocephalus acutus	12	17	11	9	11	7	5	7	9	10	15	11	1	2	1	1	1	–	–	–	1	–	–	–	–	1	–	–	–	–	–	–	–	–	67	65	132
Tuberculosis acuta	8	3	3	1	7	3	–	1	1	2	6	2	4	2	1	2	2	–	2	1	3	–	3	–	1	–	1	1	–	1	–	–	–	–	42	19	61
Phthisis pulmonum	6	6	9	7	4	3	4	6	1	4	10	15	10	15	23	16	39	31	103	74	116	56	61	40	54	25	30	23	5	9	1	–	2	–	478	330	808
Tuberculosis in aliis corp. partibus.	4	8	1	3	2	–	–	2	3	2	3	8	2	4	1	9	3	–	1	3	4	3	4	2	4	–	1	–	2	–	–	1	–	–	35	45	80
Total	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1,094
																	1889.																				
Scrophulosis	–	2	–	–	–	–	–	–	–	–	1	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	3	4
Hydrocephalus acutus	15	13	15	5	4	7	11	12	8	5	14	14	2	1	–	–	1	1	1	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	72	58	130
Tuberculosis acuta	8	12	7	1	–	4	1	1	–	1	6	8	1	5	3	1	2	3	2	2	1	1	2	–	1	–	1	–	–	1	–	–	–	–	35	40	75
Phthisis pulmonum	7	4	8	5	9	1	4	2	1	4	11	13	9	21	18	22	31	26	99	71	96	78	64	40	38	26	22	30	2	3	–	1	–	–	419	347	766
Tuberculosis in aliis corp. partibus.	–	1	1	2	4	–	2	1	–	–	4	2	1	–	2	–	3	3	–	3	3	2	6	1	5	4	3	1	–	2	–	–	–	–	34	22	56
Total	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1,031
																	1890.																				
Scrophulosis	2	3	–	–	–	1	–	–	–	1	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	3	5	8
Hydrocephalus acutus	10	8	10	10	13	9	12	6	5	6	10	8	–	1	1	1	1	1	–	3	1	1	–	–	–	–	–	1	–	–	–	–	–	–	63	55	118
Tuberculosis acuta	11	6	3	6	4	2	3	–	2	4	4	3	1	1	1	3	3	4	9	1	5	1	4	2	1	1	1	–	–	–	–	–	–	–	52	34	86
Phthisis pulmonum	8	4	7	5	4	5	1	2	5	2	16	10	7	11	22	20	31	26	80	78	92	70	65	43	46	26	29	13	2	5	–	–	–	–	415	320	735
Tuberculosis in aliis corp. partibus.	3	5	2	3	5	1	1	–	1	–	5	8	2	3	2	–	2	–	5	3	1	4	3	1	4	1	1	–	–	–	–	–	–	–	37	29	66
Total	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1,013

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Returns of Mortality from Tuberculosis in Copenhagen, classified according to Age and Sex of Patient—*cont.*

NOTE.—In the mortality returns are included people brought in from outside districts, who die in the hospitals.

	1st Year.		2nd Year.		3rd Year.		4th Year.		5th Year.		5–10 Years.		10–15 Years.		15–20 Years.		20–25 Years.		25–35 Years.		35–45 Years.		45–55 Years.		55–65 Years.		65–75 Years.		75–85 Years.		Over 85 Years.		Age Unknown.		Total of all Ages.		
	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	Both Sexes.
1891.																																					
Scrophulosis	2	1	–	–	1	–	–	–	–	1	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	4	3	7
Hydrocephalus acutus	16	16	10	14	11	5	6	7	3	5	14	17	1	2	1	–	2	2	6	1	1	–	1	–	–	–	–	–	–	–	–	–	–	–	72	69	141
Tuberculosis acuta	12	13	5	5	1	2	2	4	–	1	6	6	2	1	2	3	2	–	3	1	–	2	–	–	–	1	1	–	–	1	–	–	–	–	36	40	76
Phthisis pulmonum	3	4	6	4	5	4	6	2	1	4	9	14	2	17	21	21	37	19	87	68	80	57	53	31	33	31	29	20	8	4	–	–	–	–	380	300	680
Tuberculosis in aliis corp. partibus.	3	1	2	4	2	1	1	1	1	–	4	4	3	2	2	3	2	2	5	5	3	4	6	2	1	–	3	–	1	2	–	1	–	–	39	32	71
Total	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	975
1892.																																					
Scrophulosis	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	1
Hydrocephalus acutus	18	11	12	13	18	8	10	11	5	8	14	14	3	4	–	–	–	–	–	–	1	–	2	–	–	–	–	–	–	–	–	–	–	–	83	69	152
Tuberculosis acuta	17	8	7	5	3	4	3	3	–	2	2	4	1	1	–	1	3	4	2	5	1	–	1	–	2	–	1	–	1	1	–	–	–	–	44	38	82
Phthisis pulmonum	5	7	9	6	6	2	3	1	2	4	12	6	7	8	19	18	22	24	67	66	87	50	66	37	31	21	18	19	7	4	–	–	–	–	361	273	634
Tuberculosis in aliis corp. partibus.	2	3	2	3	1	1	3	–	1	1	3	4	3	1	3	4	7	–	7	2	4	1	3	2	4	2	1	–	3	–	–	–	–	–	47	24	71
Total	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	940
Total mortality from Tuberculosis 1883–1892. 1883	26	14	19	17	18	18	8	16	6	9	22	16	13	15	23	22	48	37	98	80	77	61	69	33	48	28	32	23	9	4	1	1	–	–	517	394	911
1884	23	33	28	31	17	22	10	14	10	18	21	23	9	21	22	32	36	35	101	108	68	66	81	43	52	39	17	29	7	8	–	–	–	–	502	522	1,024
1885	41	23	25	18	15	14	22	11	8	10	22	26	10	11	25	26	37	41	99	92	78	59	64	38	53	35	22	23	–	11	–	–	–	–	521	438	950
1886	38	36	29	16	11	15	13	4	12	8	34	34	11	17	21	29	30	33	83	92	84	64	55	31	52	35	20	24	4	4	–	–	1	–	498	442	949
1887	30	21	18	15	17	22	12	19	9	12	27	27	12	18	18	17	44	31	94	101	95	57	75	39	48	28	19	28	3	6	1	2	–	–	522	443	965
1888	34	36	24	21	25	13	9	16	14	18	38	36	17	24	26	28	45	31	106	78	124	59	68	42	59	26	32	24	7	10	1	1	2	–	631	463	1,094
1889	30	32	31	13	17	12	18	16	9	10	36	37	13	28	23	23	37	33	102	76	100	81	73	41	44	30	26	31	2	6	–	1	–	–	561	470	1,031
1890	34	26	22	24	26	18	17	8	13	13	36	29	10	16	26	24	37	31	94	85	99	76	72	46	51	28	31	14	2	5	–	–	–	–	570	443	1,013
1891	36	35	23	27	20	12	15	14	5	11	33	42	8	22	26	27	43	23	101	75	84	63	60	33	34	32	34	20	9	7	–	1	–	–	531	444	975
1892	42	29	30	27	28	16	19	15	8	15	31	28	14	14	22	23	32	28	76	73	93	51	72	39	37	23	20	19	11	5	–	–	–	–	535	405	940

1889.

INSPECTION OF MEAT KILLED IN THE PUBLIC SLAUGHTER-HOUSE AT COPENHAGEN.

—	Number of Animals sent in to be Slaughtered.				
	Oxen.	Horses.	Pigs.	Calves.	Sheep.
January Quarter	8,298	136	635	10,853	667
April Quarter	6,806	95	1,037	14,869	24,772
July Quarter	7,105	122	928	11,566	47,386
October Quarter	8,630	272	513	10,982	5,033
Total	30,839	625	3,113	48,270	77,858

Tuberculosis.	Stamped 2nd Class.					Whole Animal condemned.					Partially condemned.					Condemned Meat.	Condemned Organs.
	Oxen.	Horses.	Pigs.	Calves.	Sheep.	Oxen.	Horses.	Pigs.	Calves.	Sheep.	Oxen.	Horses.	Pigs.	Calves.	Sheep.	Lbs.	
January Quarter	388	–	97	8¾	–	Meat condemned. (Average weight of animals in brackets.) Lbs. 5,622 oxen = 70,992 - (380 lbs.) 1 horse = 536 - (536 „) 600 pigs = 3,608 - (150 „) 74 calves = 606 - (? „) 1 sheep = 25 - (25 „) 75,767										16,915½	3,161
April Quarter	379¼	–	109¾	16¾	–											15,312¼	2,714
July Quarter	354¾	–	55¾	24½	–											21,461	2,808
October Quarter	316½	–	91	14	–											22,080	2,915
Total	1,378½	–	353½	64	–											75,769	11,598

Note.—100 Danish lbs. = 1 cwt.

INSPECTION OF MEAT SENT TO THE STATIONS.

—	Number of Carcases sent in.				
	Oxen.	Horses.	Pigs.	Calves.	Sheep.
January Quarter	1,771/4	2,050/4	118,972/2	1,861/2	3/1
April Quarter	1,472/4	1,775/4	76,184/2	3,408/2	1,516/1
July Quarter	1,610/4	1,947/4	52,343/2	2,292/2	3,776/1
October Quarter	2,059/4	2,079/4	99,318/2	2,722/2	465/1
Total	6,912/4	7,851/4	346,817/2	10,283/2	5,760/1

Tuberculosis.	Stamped 2nd Class.					Whole Animal condemned.					Partially condemned.					Condemned Meat.	Condemned Organs.
	Oxen.	Horses.	Pigs.	Calves.	Sheep.	Oxen.	Horses.	Pigs.	Calves.	Sheep.	Oxen.	Horses.	Pigs.	Calves.	Sheep.	Lbs.	
January Quarter	84/4	–	1,880/2	2/2	–	Meat condemned in lbs. (Average weight of animals in brackets.) Lbs. Oxen = 1,608 - (380 lbs.) Pigs = 15,418 - (150 „) 17,026 Making 4 oxen and 103 pigs.										5,843¾	36
April Quarter	77/4	–	1,075/2	–	–											5,055	38
July Quarter	62/4	–	350/2	–	–											1,606½	55
October Quarter	65/4	–	1,474/2	–	–											4,522	37
Total	288/4	–	4,779/2	2/2	–											17,027¼	166

Note.—Larger animals are brought in in quarters; smaller ones in halves.

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1890.

Inspection of Meat Killed in the Public Slaughter-house at Copenhagen.

—	Number of Animals sent in to be Slaughtered.				
	Oxen.	Horses.	Pigs.	Calves.	Sheep.
January Quarter -	8,620	212	563	11,474	1,056
April Quarter - -	6,856	137	1,159	13,938	25,783
July Quarter - -	6,086	172	446	11,106	45,553
October Quarter -	8,216	288	468	10,265	4,086
Total -	29,778	809	2,636	46,783	76,478

Diseased.	Stamped 2nd Class.					Whole Animal condemned.					Partially condemned.					Condemned Meat.	Condemned Organs.
	Oxen.	Horses.	Pigs.	Calves.	Sheep.	Oxen.	Horses.	Pigs.	Calves.	Sheep.	Oxen.	Horses.	Pigs.	Calves.	Sheep.		
TUBERCULOSIS.																Lbs.	
January Quarter -	463	1	97¼	14½	–	39	–	–	1	–	154	–	61	8	–	26,105	3,892
April Quarter -	411½	–	78½	27½	–	66	–	–	–	–	157	–	43	10	–	34,463	3,954
July Quarter -	391	–	44½	8	–	55	–	–	1	–	95	–	34	1	–	23,980	2,951
October Quarter -	401	–	29¼	8	–	63	–	2	5	–	130	–	16	2	–	28,690½	3,505
Total -	1,666½	1	249½	58	–	223	–	2	7	–	536	–	154	21	–	113,238½	14,302
OTHER DISEASES.																	
January Quarter -	93	14¼	24¾	104¾	4¼	16	2	2	24	5	43	3	12	13	5	9,625	2,225
April Quarter -	143½	11	41½	119¾	118¾	15	–	3	25	7	27	3	31	19	79	7,779	2,452
July Quarter	116	15½	19¼	91¾	262	6	2	4	10	28	23	5	13	12	90	5,806	2,162
October Quarter -	100¾	19¼	11¼	127¾	27¼	20	2	–	12	4	40	3	5	10	6	9,560½	1,393
Total -	453½	60	96¾	444	412¼	57	6	9	71	44	133	14	61	54	180	32,770½	8,232
GRAND TOTAL (all diseases)	2,120	61	346¼	502	412¼	280	6	11	78	44	669	14	215	75	180	146,009	22,534

Note.—100 Danish lbs. = 1 cwt.

1891.

Inspection of Meat Killed in the Public Slaughter-house at Copenhagen.

—	Number of Animals sent in to be Slaughtered.				
	Oxen.	Horses.	Pigs.	Calves.	Sheep.
January Quarter -	7,374	203	443	10,554	1,088
April Quarter - -	6,810	125	425	13,921	20,198
July Quarter - -	6,329	165	432	10,850	51,238
October Quarter -	8,474	227	414	10,174	7,749
Total -	28,987	720	1,714	45,499	80,273

Diseased.	Stamped 2nd Class.					Whole Animal condemned.					Partially condemned.					Condemned Meat.	Number of Animals attacked.				
	Oxen.	Horses.	Pigs.	Calves.	Sheep.	Oxen.	Horses.	Pigs.	Calves.	Sheep.	Oxen.	Horses.	Pigs.	Calves.	Sheep.		Oxen.	Horses.	Pigs.	Calves.	Sheep.
TUBERCULOSIS.																Lbs.					
January Quarter -	400	–	39	6	–	69	–	–	6	–	75	–	21	–	–	31,817	1,238	–	56	13	–
April Quarter -	285	–	41	15	–	92	1	2	2	–	44	–	28	1	–	37,873	1,129	1	61	18	–
July Quarter -	319	–	29	9	–	81	–	1	4	–	36	–	29	–	–	28,950	1,035	–	54	13	–
October Quarter -	354	–	21	4	–	85	–	2	1	–	31	–	27	–	–	31,576	1,272	1	48	5	–
Total -	1,358	–	130	34	–	327	1	5	13	–	186	–	105	1	–	130,216	4,674	2	219	49	–
OTHER DISEASES.																					
January Quarter -	78½	9½	9½	167	1	10	–	1	29	1	42	4	8	13	1	6,136	1,313	87	57	241	18
April Quarter -	86	12	13	141½	46¼	12	2	2	33	6	30	6	6	10	56	7,483	1,476	28	54	231	294
July Quarter -	38¾	25½	11	122½	142¾	12	2	–	20	31	21	8	11	11	81	7,351	1,176	44	43	170	518
October Quarter -	63½	17	13¼	132½	29½	9	1	–	22	6	25	6	7	15	13	5,396	1,570	45	50	182	125
Total -	316¾	64	46¾	563½	219½	43	5	3	104	44	118	24	32	49	151	26,366	5,535	154	204	824	955
GRAND TOTAL (all diseases)	1,674¾	64	176¾	597½	219½	370	6	8	117	44	304	24	137	50	151	156,582	10,209	156	423	873	955

Note.—100 Danish lbs. = 1 cwt.

1892.

Inspection of Meat Killed in the Public Slaughter-house at Copenhagen.

—	Number of Animals sent in to be Slaughtered.				
	Oxen.	Horses.	Pigs.	Calves.	Sheep.
January Quarter - -	8,380	173	355	11,041	976
April Quarter - -	7,494	98	371	14,571	26,629
July Quarter - -	6,842	119	329	10,684	52,535
October Quarter - -	8,954	203	614	9,974	6,359
Total - -	31,670	599	1,669	46,270	86,499

Diseased.	Stamped 2nd Class.					Whole Animal condemned.					Partially condemned.					Con-demned Meat.	Number of Animals.				
	Oxen.	Horses.	Pigs.	Calves.	Sheep.	Oxen.	Horses.	Pigs.	Calves.	Sheep.	Oxen.	Horses.	Pigs.	Calves.	Sheep.		Oxen.	Horses.	Pigs.	Calves.	Sheep.
Tuberculosis.																Lbs.					
January Quarter -	445	1	32	13	–	114	–	1	1	–	67	–	23	–	–	46,645	1,683	1	62	16	–
April Quarter -	315	1	19	30	–	115	–	7	5	–	54	–	23	8	–	45,038	1,492	1	51	40	–
July Quarter - -	336	–	13	15	–	98	–	3	6	–	50	–	7	3	–	37,775	1,277	–	24	23	–
October Quarter -	333	–	48	18	–	91	1	4	5	–	56	–	41	3	–	36,714	1,299	1	90	23	–
Total -	1,459	2	112	76	–	418	1	15	17	–	227	–	94	14	–	166,172	5,751	3	227	102	–
Other Diseases.																					
January Quarter -	76¾	12	12¼	115¾	11	14	2	–	15	–	39	9	10	10	2	6,801	1,526	36	60	181	20
April Quarter -	86¾	5	7¼	106½	48¾	16	–	3	19	3	30	2	7	9	69	7,306	1,350	16	44	193	91
July Quarter - -	61½	9	20	64	69	10	2	–	10	35	13	–	13	17	70	6,432	1,304	23	57	112	575
October Quarter -	43¾	8½	12	89	17¾	5	1	–	13	3	24	7	8	9	7	3,451	1,702	19	38	142	136
Total - -	268¾	34½	51½	375¼	146½	45	5	3	57	41	106	18	38	45	148	23,990	5,882	94	199	628	922
Grand Total (all diseases)	1,727¾	36½	163½	451¼	146½	463	6	18	74	41	333	18	132	59	148	190,162	11,633	97	426	730	922

Note,—100 Danish lbs. = 1 cwt.

1893.

Inspection of Meat Killed in the Public Slaughter-house at Copenhagen.

—	Number of Animals sent in to be Slaughtered.				
	Oxen.	Horses.	Pigs.	Calves.	Sheep.
January Quarter - -	9,346	136	526	11,195	938
April Quarter - -	11,877	61	536	14,161	31,722
July Quarter - -	9,104	79	861	11,372	53,481
October Quarter - -	11,517	173	350	18,485	7,626
Total - -	41,844	449	2,273	47,213	93,767

Diseased.	Stamped 2nd Class.					Whole Animal condemned.					Partially condemned.					Con-demned Meat.	Number of Animals.				
	Oxen.	Horses.	Pigs.	Calves.	Sheep.	Oxen.	Horses.	Pigs.	Calves.	Sheep.	Oxen.	Horses.	Pigs.	Calves.	Sheep.		Oxen.	Horses.	Pigs.	Calves.	Sheep.
Tuberculosis.																Lbs.					
January Quarter -	454	–	49	22	–	85	–	5	6	–	80	–	45	1	–	40,919	1,878	–	91	29	–
April Quarter -	293	–	44	30	–	72	–	4	14	–	58	–	46	–	–	35,601	2,959	–	78	48	–
July Quarter - -	304	2	36	22	–	100	–	7	1	–	40	–	45	–	–	38,427	2,683	2	111	28	–
October Quarter -	423	–	25	17	1	100	–	3	7	–	50	–	28	1	–	40,295	2,935	–	41	27	1
Total - -	1,474	2	154	91	1	357	–	19	28	–	228	–	164	2	–	155,242	10,455	2	321	132	1
Other Diseases.																					
January Quarter -	147¾	4	11	95½	1	7	–	1	11	–	26	4	28	15	2	4,893	1,810	16	92	150	4
April Quarter -	42½	1	9	115½	59	5	–	1	18	7	19	1	12	15	80	5,069	2,288	6	55	196	228
July Quarter - -	46	3	11	81	101¼	8	1	–	16	48	19	1	8	12	74	7,214	1,630	11	84	136	362
October Quarter -	90½	12¾	11	76	15	5	1	2	21	2	24	9	8	10	5	4,090	1,999	34	65	134	67
Total - -	326¾	20¾	42	368	176¼	25	2	4	66	57	88	15	56	52	161	21,266	7,727	67	296	616	661
Grand Total (all diseases)	1,800¾	22¾	196	459	177¼	382	2	23	94	57	316	15	220	54	161	176,508	18,182	69	617	748	662

Note.—100 Danish lbs. = 1 cwt.

r. G. S.
oodhead.

Oct. 1890.

1894.

Inspection of Meat killed in the Public Slaughter-House at Copenhagen.

—	Number of Animals sent in to be slaughtered.				
	Oxen.	Horses.	Pigs.	Calves.	Sheep.
January Quarter	12,368	113	140	12,206	1,739
April Quarter	—	—	—	—	—
July Quarter	—	—	—	—	—
October Quarter	—	—	—	—	—
Total	—	—	—	—	—

Diseased.	Stamped 2nd Class.					Whole Animal condemned.					Partially condemned.					Condemned Meat.	Number of Animals attacked.				
	Oxen.	Horses.	Pigs.	Calves.	Sheep.	Oxen.	Horses.	Pigs.	Calves.	Sheep.	Oxen.	Horses.	Pigs.	Calves.	Sheep.		Oxen.	Horses.	Pigs.	Calves.	Sheep.
TUBERCULOSIS.																Lbs.					
January Quarter	423	–	22	24	–	125	–	2	10	–	42	–	26	–	–	45,936	3,405	–	32	50	–
April Quarter	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
July Quarter	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
October Quarter	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Total	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
OTHER DISEASES.																					
January Quarter	45¾	5	2	73¾	½	15	1	–	30	1	17	2	–	10	–	8,731	2,169	12	16	138	9
April Quarter	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
July Quarter	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
October Quarter	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Total	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
GRAND TOTAL (all diseases)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

1890.

Inspection of Meat sent in to the Stations.

—	Number of Carcases sent in.				
	Oxen.	Horses.	Pigs.	Calves.	Sheep.
January Quarter	1,934/4	1,996/4	98,501/2	2,821/2	33/1
April Quarter	1,588/4	1,759/4	67,812/2	3,837/2	1,949/1
July Quarter	1,453/4	1,699/4	42,105/2	2,304/2	4,383/1
October Quarter	1,789/4	2,135/4	95,661/2	2,680/2	466/1
Total	6,764/4	7,589/4	304,079/2	11,642/2	6,831/1

Notes.—1. Large animals are brought in in quarters, the smaller one in halves.
2. These statistics are unreliable in so far as no affected parts are brought to stations for inspection.
3. 100 Danish lbs. = 1 cwt.

Diseased.	Stamped 2nd Class.					Whole Animal condemned.					Partially condemned.					Condemned Meat.	Condemned Organs.
	Oxen.	Horses.	Pigs.	Calves.	Sheep.	Oxen.	Horses.	Pigs.	Calves.	Sheep.	Oxen.	Horses.	Pigs.	Calves.	Sheep.		
TUBERCULOSIS.																Lbs.	
January Quarter	94/4	–	1,608/2	–	–	1	–	28	–	–	–	–	210	–	–	5,745	30
April Quarter	67/4	–	1,413/2	–	–	2	–	20	–	–	–	–	474	–	–	4,780½	9
July Quarter	61/4	–	639/2	2/2	–	–	–	24	–	–	–	–	208	–	–	3,252½	23
October Quarter	106/4	–	1,554/2	–	–	1	–	45	–	–	2	–	527	–	–	8,484	13
Total	328/4	–	5,214/2	2/2	–	4	–	117	–	–	2	–	1,419	–	–	22,072	75
OTHER DISEASES.																	
January Quarter	203/4	73/4	3,097/2	114/2	3/1	1	2	133	20	1	8	4	261	3	–	13,123	52
April Quarter	223/4	69/4	2,624/2	142/2	49/1	1	2	43	7	1	6	9	264	2	1	6,604½	49
July Quarter	191/4	88/4	2,052/2	77/2	75/1	–	–	30	2	–	3	3	117	1	2	4,790¼	39
October Quarter	215/4	296/4	5,212/2	186/2	8/1	–	4	38	20	–	6	13	379	–	–	8,682	58
Total	832/4	526/4	12,985/2	519/2	135/1	2	8	244	49	2	23	29	1,021	6	3	33,200	198
GRAND TOTAL (all diseases)	1,160/4	526/4	18,199/2	521/2	135/1	6	8	361	49	2	25	29	2,440	6	3	55,272	273

1891.

INSPECTION OF MEAT SENT IN TO THE STATIONS.

—	Number of Carcases sent in.				
	Oxen.	Horses.	Pigs.	Calves.	Sheep.
January Quarter - -	1,562/4	1,673/4	94,098/2	2,194/2	26/1
April Quarter - -	1,282/4	1,445/4	76,261/2	3,741/2	1,403/1
July Quarter - -	1,187/4	1,429/4	43,137/2	3,110/2	4,138/1
October Quarter - -	1,424/4	1,781/4	109,907/2	2,616/2	699/1
Total - -	5,455/4	6,328/4	323,403/2	11,661/2	6,266/1

Diseased.	Stamped 2nd Class.					Whole Animal condemned.					Partially condemned.					Con-demned Meat.
	Oxen.	Horses.	Pigs.	Calves.	Sheep.	Oxen.	Horses.	Pigs.	Calves.	Sheep.	Oxen.	Horses.	Pigs.	Calves.	Sheep.	
TUBERCULOSIS.																Lbs.
January Quarter -	38/4	–	1,406/2	–	–	1	–	33	–	–	–	–	637	–	–	6,825
April Quarter - -	56/4	–	1,073/2	–	–	1	–	34	–	–	–	–	476	–	–	5,850
July Quarter - -	22/4	–	749/2	2/2	–	1	–	24	–	–	–	–	315	–	–	4,719
October Quarter -	36/4	–	1,593/2	–	–	–	–	25	–	–	1	–	678	–	–	5,353
Total - -	152/4	–	4,821/2	2/2	–	3	–	116	–	–	1	–	2,106	–	–	22,747
OTHER DISEASES.																
January Quarter -	226/4	209/4	3,620/2	119/2	2/1	–	3	41	7	–	5	9	240	1	–	6,714
April Quarter - -	174/4	208/4	3,587/2	210/2	45/1	2	3	46	18	1	2	11	360	4	–	9,888
July Quarter - -	194/4	243/4	5,472/2	129/2	283/1	2	3	55	15	5	4	12	596	2	6	11,508
October Quarter -	94/4	265/4	6,359/2	157/2	53/1	–	3	77	6	–	5	9	1,156	1	–	15,177
Total - -	688/4	925/4	19,038/2	615/2	383/1	4	12	219	46	6	16	41	2,352	8	6	43,287
GRAND TOTAL (all diseases) -	840/4	925/4	23,859/2	617/2	383/1	7	12	335	46	6	17	41	4,458	8	6	66,034

1892.

INSPECTION OF MEAT SENT IN TO THE STATIONS.

—	Number of Carcases sent in.				
	Oxen.	Horses.	Pigs.	Calves.	Sheep.
January Quarter - -	1,335/4	1,829/4	101,305/2	2,842/2	35/1
April Quarter - -	1,016/4	1,849/4	63,531/2	4,282/2	8,290/1
July Quarter - -	900/4	1,879/4	41,671/2	3,531/2	5,468/1
October Quarter - -	1,075/4	2,199/4	95,073/2	3,519/2	735/1
Total - -	4,326/4	7,756/4	301,580/2	14,174/2	8,528/1

Diseased.	Stamped 2nd Class.					Whole Animal condemned.					Partially condemned.					Con-demned Meat.
	Oxen.	Horses.	Pigs.	Calves.	Sheep.	Oxen.	Horses.	Pigs.	Calves.	Sheep.	Oxen.	Horses.	Pigs.	Calves.	Sheep.	
TUBERCULOSIS.																Lbs.
January Quarter -	72/4	–	1,727/2	–	–	2	–	30	–	–	1	–	756	–	–	5,826
April Quarter - -	75/4	–	910/2	–	–	–	–	33	–	–	–	–	414	–	–	5,271
July Quarter - -	61/4	–	553/2	–	–	–	–	37	–	–	–	–	231	–	–	5,682
October Quarter -	35/4	–	1,399/2	–	–	–	–	49	–	–	–	–	612	–	–	8,319
Total - -	243/4	–	4,589/2	–	–	2	–	149	–	–	1	–	2,013	–	–	25,098
OTHER DISEASES.																
January Quarter -	125/4	363/4	3,549/2	130/2	1/1	2	5	47	4	1	1	7	358	1	–	8,679
April Quarter - -	118/4	263/4	3,107/2	189/2	12/1	–	1	36	9	2	3	10	231	–	–	5,488
July Quarter - -	75/4	293/4	2,357/2	149/2	148/1	1	1	41	5	11	1	16	254	–	2	6,925
October Quarter -	84/4	217/4	2,893/2	126/2	16/1	1	5	40	9	3	1	4	287	1	–	8.192
Total - -	402/4	1,136/4	11,906/2	594/2	177/1	4	12	164	27	17	6	37	1,130	2	2	29,284
GRAND TOTAL (all diseases) -	646/4	1,136/4	16,495/2	594/2	177/1	6	12	313	27	17	7	37	3,143	2	2	54,382

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1893.

Inspection of Meat sent in to the Stations.

—	Number of Carcases sent in.				
	Oxen.	Horses.	Pigs.	Calves.	Sheep.
January Quarter - -	1,069/4	2,467/4	82,379/2	3,117/2	53/1
April Quarter - -	822/4	2,294/4	64,151/2	5,551/2	4,162/1
July Quarter - - -	788/4	2,275/4	42,117/2	4,230/2	4,145/1
October Quarter - -	1,325/4	2,063/4	91,337/2	3,798/2	921/1
Total - -	4,004/4	9,099/4	279,984/2	16,696/2	9,281/1

Diseased.	Stamped 2nd Class.					Whole Animal condemned.					Partially condemned.					Con-demned Meat.
	Oxen.	Horses.	Pigs.	Calves.	Sheep.	Oxen.	Horses.	Pigs.	Calves.	Sheep.	Oxen.	Horses.	Pigs.	Calves.	Sheep.	
TUBERCULOSIS.																Lbs.
January Quarter -	2/4	–	1,011/2	–	–	–	–	19	–	–	–	–	449	–	–	3,715
April Quarter - -	16/4	–	828/2	–	–	–	–	40	–	–	–	–	364	–	–	7,437
July Quarter - -	13/4	–	613/2	–	–	–	–	34	–	–	–	–	270	–	–	5,365
October Quarter -	9/4	–	1,516/2	–	–	3	–	27	–	–	1	–	710	–	–	7,896
Total - -	40/4	–	3,968/2	–	–	3	–	120	–	–	1	–	1,793	–	–	24,413
OTHER DISEASES.																
January Quarter -	43/4	220/4	1,628/2	48/2	–	2	–	36	8	1	3	15	192	–	–	6,560
April Quarter - -	45/4	154/4	1,710/2	142/2	32/1	–	–	43	16	1	1	7	205	1	5	8,444
July Quarter - -	48/4	238/4	3,250/2	208/2	275/1	1	3	63	11	2	–	7	290	–	6	12,334
October Quarter -	170/4	95/4	3,898/2	170/2	18/1	–	1	66	10	–	26	9	482	–	1	11,210
Total - -	306/4	707/4	10,486/2	568/2	325/1	3	4	208	45	4	30	38	1,169	1	12	38,548
GRAND TOTAL (all diseases)	346/4	707/4	14,454/2	568/2	325/1	6	4	328	45	4	31	38	2,962	1	12	62,961

1894.

Inspection of Meat sent in to the Stations.

—	Number of Carcases sent in.				
	Oxen.	Horses.	Pigs.	Calves.	Sheep.
January Quarter - -	1,249/4	2,348/4	87,359/2	3,987/2	205/1
April Quarter - -	–	–	–	–	–
July Quarter - -	–	–	–	–	–
October Quarter - -	–	–	–	–	–
Total - -	–	–	–	–	–

Diseased.	Stamped 2nd Class.					Whole Animal condemned.					Partially condemned.					Con-demned Meat.
	Oxen.	Horses.	Pigs.	Calves.	Sheep.	Oxen.	Horses.	Pigs.	Calves.	Sheep.	Oxen.	Horses.	Pigs.	Calves.	Sheep.	
TUBERCULOSIS.																
January Quarter	4/4	–	1,178/2	–	–	–	–	33	1	–	1	–	540	–	–	7,634
April Quarter - -	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
July Quarter - -	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
October Quarter -	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Total - -	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
OTHER DISEASES.																
January Quarter -	48/4	117/4	2,408/2	78/2	1/1	1	–	41	7	1	1	3	359	–	–	6,028
April Quarter - -	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
July Quarter - -	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
October Quarter -	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Total - -	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
GRAND TOTAL (all diseases) -	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Adjourned until Friday, October 24th, at 2 o'clock.

SIXTH MEETING.

7, Whitehall Place, S.W., Friday, October 24th, 1890.

PRESENT:

THE RIGHT HON. THE LORD BASING PRESIDING.

Professor G. T. BROWN, C.B.
Dr. G. BUCHANAN, F.R.S.
Professor J. B. SANDERSON, F.R.S.

Mr. LEOPOLD HUDSON, *Secretary.*

Dr. EDWARD EMMANUEL KLEIN, F.R.S., Lecturer on Physiology at St. Bartholomew's Hospital, called in and examined.

Dr. E. E. Klein, F.R.S

24 Oct. 1890

538. (*Chairman.*) Dr. Klein, you are, I believe, lecturer on physiology at St. Bartholomew's Hospital?—Yes.

539. You have also had a lengthened experience in connection with the examination of special matters concerning pathology?—Yes.

540. Is it the case that you have not only experimented yourself but that you are thoroughly well up in the experiments of others in regard to the question of tuberculosis in its effect upon animals and mankind?—Yes. It is an enormous subject, but I have tried to the best of my ability to follow it up.

541. You are aware, I presume, of the report which was prepared by a departmental committee of the Agricultural Department upon this subject?—Yes, I have seen some of it.

542. You are acquainted with the blue book?—Yes.

543. Before going into the details of the evidence which we desire you to give, can you say what is the conclusion which has been arrived at generally in regard to the matter—first of all as to the identity of what is known as tuberculosis in animals and what is popularly called "consumption" in mankind?—Well, the evidence is of various kinds. There is, first of all, the experimental evidence as regards the effects of the inoculation and of the feeding of certain animals with tuberculous matter derived from bovine or human sources. No doubt there is a difference in the results which have been obtained, for instance, in the case of rabbits and guinea pigs; these have not in every case been identical. In the case of a rabbit inoculated with human tubercle and of another inoculated with bovine tubercle there is a very great difference noticed. In a rabbit the effect will be more localised when the inoculation is with human tubercle, and it will manifest itself in the spleen or lungs, but when the animal is inoculated with bovine tubercle there will be a much more rapid development of general tuberculosis. The rabbit inoculated with human tubercle would last for many months, whereas one inoculated with bovine tubercle would rapidly succumb, probably in four or five weeks, or perhaps less. In the case of a guinea pig inoculated with human matter it would go on slowly and gradually developing general tuberculosis in the viscera, taking probably 120, 150, or 180 days to develope the full effect, whereas a guinea pig inoculated with bovine tuberculous matter would show a marked difference, general tuberculosis being developed in four, five, or six weeks.

544. My question was what is your general opinion as to the identity which is sometimes assumed to exist between the disease tuberculosis in animals such as oxen and consumption in mankind. Are they the same?—Yes, they are both tuberculosis.

545. You say, as a general proposition, that both diseases are the same?—Yes; but I must qualify my answer. They are the same disease, but there is a difference between the virulence of the two. One animal inoculated with bovine matter would be infected in a much more virulent form than another animal of the same species which was inoculated by human matter. I was going on to prove my proposition by referring to experiments which have been made upon two classes of animals, rabbits and guinea pigs. Whereas human tuberculous matter would, as a general rule, be comparatively slow in developing disease, inoculation by means of bovine tuberculous matter would produce the same disease much more rapidly. The two experiments show, in my opinion, that both produce tuberculosis, but very different in degree, so far as virulence is concerned.

546. What can be more virulent than what is called "galloping consumption" in man?—You must bear in mind that that is the last stage of the disease. If you were to consider the virulence of any infectious disease, I think, you have a very good guidance and very good measure for tracing it to its source. In the case of animals, for instance, we are accustomed to find that some virus is more potent in one animal than in another of the same class. If you inoculate two animals of the same kind with the same matter you will find that in one the virus causes quicker and more intense results than in another.

547. Assuming for a moment that the two diseases are the same, and that they are more or less communicable from mankind to an animal, or *vice versâ*, the situation is practically similar, is it not?—Yes.

548. Let me take, as a case in point, the well-known instance of small-pox in mankind, and the disease, whatever it is—the vaccine disease in cows or calves. In that case, as you are aware, the disease is less virulent in the animal than it is in the man, and you only inoculate the milder disease. Now, in the case of tuberculosis, assuming the disease to be the same in animals as in man, you say that the disease is very much more virulent in the bovine species of animals than in mankind. It is therefore on an opposite footing in that respect from the well-known disease which is communicated to mankind by vaccination?—Yes, and there are several diseases in which that is really the case. For instance, anthrax derived from the bovine species is very much more virulent than it is derived from sheep, and it is much more virulent again derived from oxen and sheep than it is in a guinea-pig. We are therefore quite familiar with the fact that certain diseases are much more virulent in animals of the bovine species than in other animals.

549. Taking into consideration the communicability of tuberculosis in animals to mankind, laying it down as an undoubted proposition that the two diseases are the same, would you go so far as to say that if tuberculosis could be extirpated from animals we should practically be in a fair way of getting rid of the disease in mankind?—I cannot say that. It is possible.

550. You think it is possible and probable?—Yes, but there is no direct evidence that it would be so.

551. Do you hold, with a previous witness, who has been examined before the Commission, that all tuberculosis in man is contracted, like typhoid, for example, by the poison either imbibed, ingested, or inhaled from external sources?—Yes, or inherited.

552. That is the very point I am anxious to get at, we have been told that it is only the disposition to catch it that is inherited; that the tubercles or poison

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which cause disease must be caught like other infectious diseases such as typhoid?—It is very difficult to form a judgment from the human subject, because our experience is limited, and must necessarily be limited, but so far as animals are concerned we know that tuberculosis is inherited.

553. That it is inherited?—Yes, over and over again in young calves the tubercles and *tubercle bacilli* have been found in the spleen and mesenteric glands, deposits which, from the age of the animal, could not have been contracted except from the mother. There are many other instances in which tuberculosis has been shown to have been inherited, and I am under the impression that they have been published.

554. As you know that it has been the case in animals, do I understand you to assume that it must also have been a frequent cause of tuberculosis in mankind?—I would not say a frequent cause, but what I will say is that besides this disposition, as it is called, to tuberculosis, owing to the inheriting of it from a tuberculous parent, I think that as regards animals there is distinct evidence that tuberculosis is inherited from the parent, I am speaking of a tuberculous disease which may be contracted otherwise than by ingestion, injection, or inhalation, a disease which may, in fact, arise by transmission from parent to offspring.

555. Then you rather differ from what we have heard before. You assume that a great deal of tuberculosis in animals and what is called consumption in man may be inherited and not contracted by way of infection?—I did not say a great deal.

556. But you are of opinion that some of it may be inherited?—Yes, I think that inheritance may be one of the sources of tuberculosis.

557. Consumption is one of the most common diseases in the world, is it not?—Yes, speaking generally.

558. In some parts of the world at all events?—Yes, in this country, for instance.

559. Do you identify consumption in grown-up people with the infantile form of disease—*tabes mesenterica*—which attacks children?—I think that *tabes mesenterica* is most probably a disease contracted by children by ingestion, by being fed with some material which contains *tubercle bacilli*. There is a large amount of tuberculous matter about in the streets and in all places where a large number of people congregate. No precautions are taken to prevent such tuberculous matter from spreading; it may be given off by expectoration, mixed with the dust, and in that form inhaled with the breath or swallowed.

560. I would rather put it to you whether the prevalent disease of consumption among children may not be caused by the drinking of tuberculous milk, which would convey the infection to them from the cow?—It is quite possible that a percentage of it is caused in that way.

561. Am I to understand that you do not think the greater part of it is caused in that way?—I cannot say. I should not like to say so. I am speaking of that form of infantile tuberculosis which is known as *tabes mesenterica*. I should say that most of it is contracted by feeding on tubercular matter, but whether it is milk or not I should not like to say. It is a form of tuberculosis which arises from ingestion, the deposit of *tubercle bacilli* occurring in the abdominal viscera.

562. The object of our inquiry here is to ascertain what is the effect, if any, of food derived from tuberculous animals on the general health of human beings, and, if prejudicial, what are the circumstances and conditions with regard to the tuberculosis in the animal which produce that effect upon man. Have you come across any experiments, either personally or in reading, which satisfy you that any public danger is caused by the carelessness with which beef, for example, is consumed in this country?—I cannot say that I have come across any personally which have established that result, but I have seen a great many statements on the subject, more or less based on circumstantial evidence, that tuberculosis has probably been caused, for instance, by feeding on tuberculous milk.

563. We know that you are a great authority upon this subject, and we should like to know some of the conclusions at which you have arrived?—I have arrived at the conclusion that milk and flesh derived from animals infected with tuberculosis are dangerous.

564. Dangerous for consumption as articles of food?—Yes. But that is very different from saying that they have actually been the cause of disease. I certainly would consider the consumption either of meat or milk from tuberculous animals as dangerous.

565. Am I to take it that you think, as far as your experiments have gone, they show that ordinary flesh, exposed in the butchers' shops, which has passed the inspection of the market authority, and appears to be good and wholesome and fit for food, can involve any possible risk if made use of as food by the people at large?—It would entirely depend upon what the condition of the animal was at the time it was slaughtered.

566. I am quite aware of that, but I am speaking at this moment of the popular view of what is exposed for sale as food in the butchers' shops. The meat we see in the butchers' shops is apparently healthy, and has passed through the ordeal of the market inspection. Do you think that there is any appreciable risk to the public health by the use of that meat as an article of diet?—I think there would be some risk.

567. Why?—For this reason: that an animal may have had tubercles in the lungs and the abdominal viscera without having any apparent tubercles in the flesh or muscles. Yet we know perfectly well, both as regards artificial tuberculosis produced by the inoculation of animals and tuberculosis contracted by other means, that *tubercle bacilli* are deposited in the marrow of the bones, and that that is one of the earliest symptoms of the existence of tuberculosis.

568. But people, as a rule, do not eat the marrow of the bones?—No, but it shows that the *bacilli* are there, and that it is possible for the *tubercle bacilli* to be circulated through the blood and the muscles.

569. Assuming that there are *tubercle bacilli* in the stomach and internal organs of the animal, does it follow from that fact, in your judgment, that there is any appreciable risk incurred by the public in eating what is, apparently, wholesome beef and mutton?—I should certainly think that there is a risk.

570. A risk and a danger to the public health?—I am certainly of opinion that any animal with the smallest amount of tuberculosis may contain in the circulating blood the *tubercle bacilli* in transit to different parts of its body, and therefore its flesh should not be eaten.

571. Are you aware of any cases which have occurred in your experience or in your knowledge of consumption having been contracted which could not be accounted for except through the eating of tuberculous flesh?—I do not know of any case myself.

572. If it can be assumed that the risk is infinitesimal a great point will have been gained, but we want to know, as a matter of fact, whether the consumption of ordinary decent-looking meat anyone may buy at the butcher's shop can be appreciably dangerous to the man who eats it?—I should certainly say that there is a risk to the public if it were the fact that the animal had been suffering from tuberculosis. But all persons would not be equally susceptible to an attack of tuberculosis. There would be, in my opinion, a decided risk in eating the flesh of an animal that was tuberculous.

573. I do not put it as a case in which the flesh came from an animal which was apparently diseased or was palpably improper to be used as human food. My question is rather, whether at any time, and under what circumstances, there has been a growth of this disease among mankind which can be accounted for or supposed or suspected to be accounted for by the consumption of meat which was really injurious to health although apparently

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free from tuberculosis. Can you go so far as to say that ?—I do not think I can say that. We have no statistics as to the number of tuberculous individuals who have been infected with the disease. For many years, although the existence of disease was very well known, before Koch discovered the bacilli of tuberculosis, physicians were not particularly clear as to whether all cases of consumption or phthisis were tuberculosis or chronic pneumonia. The diagnosis has only been possible since the *tubercle bacilli* were discovered, and it is now held to be tuberculosis, the same as it is in animals. I think it would be very difficult to make a more explicit statement as to the nature of the disease or the way in which it is contracted and spread.

574. But we are engaged, at this moment, in an inquiry which is a very difficult one, and we wish to have all the light thrown upon it we can get. It is with a view of assisting us in arriving at a conclusion that I have deemed it necessary to ask you some of these general questions. Do you think it follows because guinea pigs and rabbits can be infected with disease by eating tuberculous flesh or being vaccinated, so to speak, with this matter, that the eating of meat by human beings or the drinking of milk by human beings can so readily or is likely so readily to infect mankind ?—Of course there are many points which tend to show that the disease in man being tuberculosis, and the disease in the inoculated animal being also tuberculosis, the infection has been transmitted to the animals experimented upon. It is also clear that as the infection can be transmitted from one animal to other animals, the disease must have a common origin, although there may be a slight difference owing to special circumstances in the growth of the *bacillus*, and so on. I think we are fairly enabled to say that the disease in mankind and in animals is one and the same disease, although not always equal in virulence. Human tuberculosis is transferable to all the animals which have been experimented upon, and bovine tuberculosis is also similarly transferable in a greater or less degree to those animals. That being so, I think we may say that the two diseases, human tuberculosis and bovine tuberculosis, must also be one and the same. There has been no direct experiment made, as far as I am aware, in transferring human tuberculosis to cows or oxen, nor has there been any direct experiment the other way. Of course, it is obvious that, in the latter case, no direct experiment could be made.

575. Do you think that there has been any defect in the series of experiments, as far as they have been tried hitherto ?—No, I think they have been proper experiments.

576. Would you like to do anything else in order to ascertain the co-relation between the disease in man and in animals ?—I think it might be desirable to make some experiments on animals of the bovine species. There have been statements made, I know, although I have not read any detailed articles upon the subject, and I should like to point out that further experiments are desirable. I believe that Professor Brown, for instance, has been making such experiments.

577. Professor Brown is experimenting every day. He is going on with them now. The question, however, is whether the Commission should institute experiments. I think I may take it from you that you cannot point to any salient facts or striking instances which show that the health of mankind, in regard to consumption, is vitally or seriously prejudiced by the use of ordinary beef and mutton as articles of diet ?—I myself believe that it is very possible to be so, and I consider it dangerous to allow tuberculous material to be used as food.

578. I am assuming that ordinary and due care is exercised in the market, and that the appearance of the meat is sufficient to throw one off one's guard and dispel any alarm that there is any risk of becoming consumptive from eating it ?—I would not advise any one to eat beef of that kind.

579. You would advise that it should be rejected ?—Yes.

580. I am assuming that the beef, as far as one could judge and see, was free from any taint of disease or impurity ?—That is the difficulty I am in. I could not assume that the meat was diseased unless I saw tubercular nodules in it; but, at the same time, I should not be entitled to say that it was perfectly free from all taint of tuberculosis if it did not show them.

581. In order to justify you in saying that it was free from tuberculosis would it not be necessary to analyse and examine every piece of meat consumed in England for example ?—I should certainly go so far as to say that I would prohibit the sale for food of all meat which came from tuberculous animals. That would save the trouble of examining every piece of meat offered for consumption. An examination of that kind would be impracticable. I should feel inclined to proceed in this way. If I found when an animal was slaughtered that it showed the presence of tubercular nodules in the lungs, I should look for them in the other viscera, and if by the aid of a microscope and other means I found that they existed in the lymph glands, and that there were in them tuberculous deposits, I should proceed at once to direct that the meat should be destroyed.

582. No doubt that would be a perfectly justifiable course when the presence of disease was made apparent ?—If I did not find any tuberculous deposit I should make experiments, and if I did not then discover tuberculosis that would be a negative, and would go for what it was worth. I should, however, put a label upon the meat, and not allow it to be offered as good food in the shops for sale.

583. Who would you entrust with the carrying out of this function throughout the kingdom ?—That is difficult to say.

584. If we should form an opinion or entertain a suspicion that the want of the exercise of the extreme and minute precautions you have pointed out are a source of danger to the public health, it would be necessary, I take it, that some means should be devised for preventing the exposure for sale of meat that may be dangerous to the public health ?—Certainly.

585. Then, however difficult that point may be, it would be necessary for us to consider it, notwithstanding the fact that the probability of transmitting infection might be extremely rare, and that to most reasonable persons the healthy appearance of the meat would be a sufficient warrant that after being cooked it might be consumed as food. Would it not be necessary to invest the inspectors with power to order its destruction if any single portion of the carcase evinced symptoms of infection ? That would be a very responsible duty to perform, and yet it would have to be performed, if we are told that consumption is largely on the increase, and that it may be kept up by allowing the general public to eat beef obtained in the butchers' shops, notwithstanding the fact that it is apparently sound and healthy ?—No doubt the duty would be a responsible one, but it is one which must devolve upon the authorities. I do not see, however, how it is possible to do away altogether with the danger.

586. I understand you to show very clearly that the healthy appearance of meat, after it is prepared for sale, is no guarantee that it has not come from a highly tuberculous animal, and may contain the germs of disease in it ?—I would not say from a highly tuberculous animal, but what I do say is that the healthy appearance of the meat is no guarantee that it has not come from a tuberculous animal.

587. I rather want to get it from you, in one way or the other, whether the risk is not so rare that it is not worth while to be over-anxious about it; or whether, on the contrary, you are of opinion that the danger is so great, and the mischief already has been so serious, that some very great check as to the handling and management of the animals is required ?—I do not know that I should be prepared to say that. I would not perhaps be justified in saying that if we could save one human being from contracting tuberculosis I would not object to the slaughter of all the animals in the United Kingdom.

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588. Let me go now to another point. It is only in recent years that the inspectors of markets have been armed with the special power of condemning diseased meat. Are you able to say whether any good results have followed from the exercise of that power? Is there, at this moment, less consumption prevalent in the United Kingdom than there was before this power was conferred upon the market inspector?—I am not aware that anybody has paid attention to that point.

589. We had a gentleman here the other day who told us that meat in Manchester had been condemned in this way by the market inspectors, although the appearance of the meat was such as to induce the dealers to prepare it for sale. He said that the carcases of four animals were, on examination, found to be highly tuberculous, but that in that case there was no difficulty in detecting the disease. The question is, then, if the improper condition of the meat was such as to render the presence of infection apparent to the naked eye, there was not sufficient justification for ordering the destruction of the carcases without further examination?—If the meat was conspicuously unhealthy, there would be no difficulty in dealing with it, and ordering it to be destroyed. But, I think, I understand you to ask me whether there has been any decrease in consumption noticeable since the inspection of meat, and its condemnation, if found to be diseased, was ordered?

590. Yes?—I am not aware whether anyone has paid special attention to what may be called the statistics of tuberculosis since that time.

591. The evidence given to us was that in Manchester four of these carcases were condemned simply in consequence of their appearance, and it was found, on further inquiry, that the animals had been infected with tuberculosis. But the fact was discovered and made known before any mischief was done by exercising the ordinary protective power supplied by the Public Health Act. The question is whether we may rely on this being done in a general way. Although we may admit that inspection is possible under conditions in which it cannot be so easily discerned, may I ask if it is not rather a modern discovery that so much of what we fancied to be disease naturally produced is, in point of fact, infectious disease caused by the ingestion of some kind of poison?—Those diseases which are communicable are caused by specific poisons which, as far as we can judge, are different in different diseases, and are represented by different microbes. Tuberculosis is one of these diseases, and it has been conclusively proved that it is a disease which is produced by the introduction, in one way or another, into susceptible individuals of the particular microbes which produce the infection.

592. You are speaking now of the disease which is popularly known by the name of tuberculosis?—Yes.

593. I do not understand you to say that it may not be produced in another way because you say that it may be inherited?—Yes, the mother may have had tuberculosis and may have transmitted it to the child.

594. One of the witnesses examined before us went so far as to say that tuberculosis or consumption is always produced by infection of some kind; by the action of external agents. You do not agree with that?—It would depend upon what he meant by infection. It might be infection by contracting the disease from the mother, which, certainly, may be the case. A child may inherit the disease from the mother, as the fœtus before birth. This may also be termed infection.

595. Are you cognisant of the proceedings which have been taken in Copenhagen with a view of checking the consumption of dangerous meat as food?—No, I am not.

596. If meat is capable of conveying this infection to mankind, or to the consumers of it, much more, I take it, would milk, which is a substance highly capable of conveying infection, is it not?—I should say so. In the first place, a great deal of milk is consumed in a raw state.

597. Would boiling it remove the infection as roasting meat is said to destroy tuberculosis?—I do not think that roasting would much interfere with the infection, but the boiling both of meat and milk would probably do so.

598. Generally speaking, the cooking of meat and the boiling of milk would diminish the risk of transmitting disease?—Yes, the boiling of milk would certainly do so provided that it were thoroughly boiled. The experiments which have been made in the laboratory have taught us that the germs of the disease are destroyed by boiling.

599. I think it would be as well if you were to give us a full explanation of one of the propositions which you submitted just now because it differs from what we have heard from another witness. I understood you to say that tuberculosis need not be contracted by infection, but that it may be inherited by the child from the mother, do you mean that the child may be born with it, or that having a weakly and delicate constitution it is liable to contract it?—I was referring more to my own observations in reference to animals, and in saying that the disease, tuberculosis, is inherited I form my judgment from this, that I have found it existing in animals too young to have contracted the disease by feeding or inoculation or in any other way; but they must have inherited it, and I have found that at birth there were already present distinct tuberculous deposits.

600. I was not speaking of animals, but of children. Have you observed the same thing in young children?—Well, in children, the widely-accepted view is that when tuberculosis appears in young individuals it is due to the infection in some cases enhanced by an inherited weakness of the lungs. Undoubtedly it is the fact that certain individuals have derived from weakly parents a greater predisposition to infection than other individuals whose parents have been more healthy and have possessed stronger constitutions.

601. Have not the children of healthy English parents manifested symptoms of lung disease or consumption?—Yes.

602. Do I understand you to say that in that case the child must have contracted the disease by means of infection?—Yes.

603. That is so?—Yes, I think so. There is no other way of accounting for it. In the case of a child or a young person of a weak constitution, born probably of tainted parents, I should say that such an individual may contract tuberculosis in two ways.

604. What are they?—He may have been born with the seeds of disease in him or he may possess a greater predisposition towards contracting tuberculosis by infection, which, as we are all aware, is a very widespread disease.

605. Do you think that perfectly healthy people, having no hereditary predisposition at all towards contracting this disease, and not looking as if they were consumptive, which is the popular way of describing persons who are suffering from tuberculosis; do you think, as a matter of fact, that many of those people may become infected with consumption by eating tuberculous meat?—I cannot say.

606. Do you think so or not, speaking from your experience and the knowledge you have otherwise acquired?—I should say that a portion of them may.

607. I mean perfectly healthy people?—Yes, it is possible.

608. You and I and others who are sitting around this table?—No, I do not think we should contract it because we have passed the age when, as a rule, persons become infected with tuberculosis.

609. Why should we not contract it if it is infectious, and we are capable of being infected?—I cannot explain; but it would appear that, after reaching a certain age, we possess a power of resistance in regard to the infective material which younger persons do not possess, and which renders them more liable to be infected by the disease.

610. You say that susceptibility forms part of the liability to contract the disease?—Yes, in this way,

that it predisposes a person to take the disease. You and I cannot take small-pox because we have been vaccinated, whereas another person who has not been vaccinated would take small-pox.

611. Do I understand you to say that people may be saved from the danger of tuberculosis by being vaccinated with it?—No, I do not say that; all I say is that, in regard to small-pox, we have been rendered free from susceptibility by vaccination. In the case of other diseases there is a natural susceptibility. There is a well-known example—the case of anthrax. Cats and dogs, and animals of that kind, have very slight susceptibility towards contracting anthrax, whereas herbivorous animals have a great susceptibility to it, and easily contract it. Cats and dogs have not much susceptibility to tuberculosis.

612. You refer to animals, but it is quite another thing to divide mankind into those who are susceptible to tuberculosis and those who are not?—I should certainly say that you and I are not susceptible to tuberculosis, because we know it is a disease which is contracted chiefly by the young; our experience teaches us that after we have reached a certain age we are not likely to contract the disease.

613. Your hypothesis is that the disease may be contracted by those who are susceptible to it by eating, say, a sirloin of beef, as well as by inhaling the germs of the disease into the lungs?—Yes, precisely so. But one person may be susceptible, whereas another person may not be. It is just the same in animals. One animal will contract disease, whereas another, under precisely similar conditions, will not.

614. Let me carry you back for a moment. You spoke of inheriting a susceptibility or a predisposition born with certain persons to become infected with this disease. Now, suppose we take 1,000 cases of consumption among children and adults, what number per cent. would have inherited the disease and what number per cent. would have acquired it by inhaling the poisonous matter?—I have not the slightest data to go upon, and am altogether unable, therefore, to answer the question.

615. You refer, in a paper which I have here, to experiments in the Brompton Hospital?—Yes.

616. How far do those experiments show that the emanations from consumptive patients can affect animals?—They only serve to illustrate the point that tuberculosis can be easily contracted by inhaling the virus.

617. Does it follow that if a guinea pig, when brought into an infected place, can contract the disorder from a consumptive patient, does it follow that a person who is not otherwise consumptive would become consumptive from eating tuberculous flesh?—That would involve two different and distinct kinds of experiments.

618. Of course it is difficult to carry out experiments where human beings are concerned. Can you tell me—I believe it is the fact—whether consumptive people after death are found to have tuberculous disease, not merely in the lungs but also in the limbs?—The *tubercle bacilli* have been discovered in the marrow of the bones.

619. I do not mean in the marrow of the bones, but in the flesh?—I think that the results of some of the experiments which have been made seem to indicate that.

620. Then if that be so, and is a well-known and ascertained fact, would it not be another illustration in support of the assumption that the two diseases are identical? If the infected matter pervades the whole body, and is not confined to the lungs in mankind, and if the same thing occurs in tuberculous oxen, does it not make the danger from eating the meat from an infected animal more real?—The expression "pervades the whole system" ought to be qualified to a certain extent. An individual may have tuberculosis in the lungs, but the tuberculous virus would not be confined strictly to the lungs. A good deal of it would be absorbed, and would circulate in the body and blood, and be deposited in other organs. Then again, as I have said, it will be found in the lymph glands and in the marrow of the bones.

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621. I do not care so much about the marrow in the bones. Very few people eat marrow from the bones, but a great number of people eat beef?—I was only referring to the fact to show that distant localities are invaded by tuberculosis, and the invasion could only take place through the blood stream. Therefore, tuberculosis may in its passage to different organs affect the muscles and other parts of the system.

622. (*Prof. J. B. Sanderson.*) The first question I have to ask is, whether in a tuberculous animal, the meat being apparently healthy, any danger exists from using it?—I have been trying to explain what my view is: I do believe it to be dangerous.

623. Will you state why?—I believe it to be dangerous for the reason that the tubercular virus, although it cannot be demonstrated by the microscope or by general inspection to be present in the muscles, may, nevertheless, be in transit through the muscles and body. I cannot understand the infection of tuberculosis and the deposit of *tubercle-bacilli* in distant lymphatic glands and in the marrow of the bones to be carried out in any other way than by means of the blood stream; we must therefore assume that the *tubercle-bacilli* get in the blood stream from a point where there may have been tuberculosis of some standing, and they are distributed by the blood stream to different organs.

624. And therefore you say there is danger in eating the flesh of an animal which has been infected by tuberculosis?—Yes. I maintain that there is risk in eating the flesh of an animal in which tuberculosis has been present, although it may not be readily detected in the muscles. There have been experiments made which show that the muscles, although apparently healthy, have contained *tubercle-bacilli.*

625. (*Chairman.*) Upon that point allow me to put a question. I quite understand you to say that the experiments show there may be extreme risk, but I do not understand you to say the experiments show that the risk is real, and has had an actual prejudicial result?—I say that the risk is quite real, and that by inoculation of flesh from infected animals tuberculosis has actually been produced in other animals.

626. But not in man?—Of course not: you would not try the same experiments upon a human being.

627. (*Prof. Sanderson.*) I want you to give us, as clearly as you can, a definition of what the essence of tuberculosis is?—The essence?

628. Yes, the essence?—In what sense the essence?

629. I mean, what, in your opinion, goes to make up the essence of tuberculosis?—If I saw in the lungs or in the abdominal organs, or in the lymphatic glands, or in the marrow of the bones, a grey nodule or a grey patch, or a yellow nodule or patch, I should at first think that it might be tuberculosis. I should then use the microscope and employ proper means to bring out the *tubercle-bacilli*, and if I found they were there I should at once say that it was certainly tuberculosis. I should like to mention a striking illustration that came within my knowledge last year. It was a case of multiple abscess in the brain. There was a discharge, but nothing could be seen in the *pus.* There were symptoms, however, during life which pointed to its being a case of multiple abscess. The patient died. An examination was made and *tubercle-bacilli* were found in the sac of the abscess. It was undoubtedly a case of tuberculosis, and I should think that all the authorities would agree in that, seeing that *tubercle-bacilli* were found to be existing. Perhaps I ought to add this fact: that there are forms or stages in the development of tuberculosis in which it is difficult to demonstrate the presence of *tubercle-bacilli.* In such cases it is necessary to make experiments. I have myself made a large number of experiments with Lingard, Gibbes, and others, in regard to the well-known grey tubercular deposits in guinea-pigs. The liver after a few

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weeks would show a peculiar grey mottling, which led afterwards to *caseation*. We have in this grey material, most distinctly, a tuberculous deposit, but I could not find any clear signs, even with the use of a microscope, of the existence of *tubercle-bacilli*. But in experimenting with such material upon animals I have invariably produced tubercular deposits with all the symptoms of tuberculosis. If I did not find *bacilli* at once I would have recourse to inoculation.

630. Then in short, I may say that, in your opinion, infectivity and certain other things constitute a definition of tuberculosis ?—Yes.

631. Would you take in heredity as part of the essence of the disease ?—That is a question upon which, I think, we have not yet sufficient direct evidence.

632. In reference to the general belief of pathologists, do you think that any material change has taken place in that belief—I mean in the general belief that tuberculosis on the whole is a disease which mostly arises from heredity ?—Well, that is not the result of the experiments whichhave been made. The experiments Villemin, of Wilson Fox, yourself, and others, show that tuberculosis can be communicated by ingestion or injection, and that the system undergoes a change. No doubt the possibility of its being a disease that may be inherited has been opened up, but it is fair to assume, as the result of the experiments, that some of the tuberculosis in the human subject is contracted in some other way than by inheritance, namely, by the food eaten or by breathing a tainted air, and so on.

633. The point I want to get at is this : Is there any less evidence now than there was formerly, that the susceptibility to tuberculosis in man is hereditary ?—Any less evidence ?

634. Yes—I should say that the evidence is less.

635. Is it not the case that all the facts which before led to the belief that it was so, are still just as cogent as they were ?—Yes, I think they are. Children derived from tainted parents are believed to bring with them a great predisposition to contract the disease.

636. (*Chairman.*) Can they catch it, so to speak ?—I think so.

637. Can they have consumption without catching it, in the first instance; can they develop it ?—There again it is quite possible to imagine—not that there is any certain evidence, because the experiments have necessarily been confined to animals—that a percentage of them will have the germs of the disease, that is, the taint.

638. Not only is there a certain weakness of constitution, but they bring with them the germs of disease, having derived it from the parent in the uterus ?—Yes.

639. Having a weak constitution and a predisposition to the disease children so circumstanced are easily infected if exposed to infection ?—Yes, but I am not prepared to say that all children get it by bringing with them the germs of the disease. I should not like to say that they do not get it by infection.

640. Suppose that anyone dies of consumption at the age of 25 or 30, would you say that it is possible to have got the disease from inherited taint ?—Yes.

641. No tuberculosis having developed itself up to that age ?—Yes, it is quite possible.

642. That the person infected had not contracted the disease by inhalation or infection ?—I think it is possible that he may have had the disease in him.

643. And that he had lingered with it in him for 20 years or more ?—I do not see why that should not be the case.

644. I do not dispute your authority. I only want to know what your opinion is ?—I think there is really no precise evidence which enables us to say exactly. We know that people have developed tuberculosis 20 or 30 years after it must have been derived from tainted parents, if inherited. But they may have contracted the disease without having inherited it in the first instance. The probability is that they did so ; that they contracted the disease *de novo*.

645. (*Prof. Sanderson.*) Would you rather define your opinion with reference to the hereditary character of the disease as an hereditary susceptibility or a direct susceptibility ?—I should say hereditary, as relative to the disease, but I ought to add to that remark what is suggested by the transmission of the tuberculosis from the parent to the offspring. In animals that may mean the direct transmission of the disease from the parents to the offspring, while in mankind there may be only a predisposition. I do not think we can say that children are only susceptible who have weak tissues, nor do I think it right to say whether a large or a small percentage of persons have inherited tuberculosis from their parents as tuberculosis. We know as the result of direct experiments on animals that tuberculosis is transmitted as direct tuberculosis to the offspring, although that does not occur in a very large percentage of cases. It certainly does occur in some.

646. You say that your definition of susceptibility is one you derive from examples which have come under your observation in the course of the experiments you have made ?—Yes.

647. I think you have made some observations in regard to congenital tuberculosis in calves ?—Yes.

648. Will you state what, in that case, the morbid appearances or symptoms were ?—I worked upon a number of calves in connexion with certain cutaneous disorders, particularly in reference to eruptions in the udder of the cow. The experiments were made upon young calves which were afterwards found to show some nodules in the mesenteric glands. There could be no question as to their being tuberculous. The calves were too young to have contracted the tubercles, say, owing to their having been fed upon tuberculous milk.

649. How long was it before the tubercles were developed ?—About six or seven weeks.

650. Were they so advanced that they could not have been obtained otherwise than by congenital means ?—Yes.

651. Then may we consider that as an instance of congenital tuberculosis in calves ?—Yes.

652. Was it tested by experiments ?—It was the result of an experiment.

653. (*Chairman.*) That is an instance of the disease having been very active from birth ?—Yes.

654. What I put to you just now was the possibility of the disease having remained latent for 25 or 30 years ?—I quite understood, and my answer is that that is quite possible.

655. (*Prof. Sanderson.*) Speaking of the possibility of prolonged latency for 20 or 25 years, is it generally admitted by human pathologists that that is so ?—Yes.

656. Twenty years would be a long period for any disease to remain latent ?—No doubt.

657. What is the period in human life in which in an ordinary case of hereditary tuberculosis the tuberculous symptoms usually first appear ?—That is a question that requires consideration. In the first place, I am not quite clear about all the cases of tuberculosis in young children. Of course there is a possibility that the disease may have been contracted in some way or other by the children having been exposed to infection. I am not at all clear about it. One should exclude all such cases from the question of hereditary taint. There have certainly been some cases of tuberculosis in children in which the disease has not been derived from tainted parents. You will remember that some years ago I was working with you in connexion with the subject of acute miliary tuberculosis in children. At that time I went into the history of some of the children. In some cases there was no family taint at all, and in others it merely complicated the question. If the disease had in all cases been in the children derived from healthy parents, I should have been able to say that it had been contracted by the children having been

Dr. E. E. Klein, F.R.S.

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exposed to infection. But that was not the case, because some of the children might have derived it from hereditary taint. Others undoubtedly did not.

658. It is not in that form that the tubercles usually supervene ?—No, that is not always the form. More frequently you get pulmonary tuberculosis.

659. When that is the case, at what period of life does it develop itself?—About and after 20 years, I should say.

660. In some of your papers you have spoken of the mitigation or attenuation of the tuberculous virus in animals. Will you mention one or two examples by way of illustration ?—I studied this question by inoculating animals with certain cultivations of *tubercle-bacilli*. I have been able to form a judgment of the attenuation by the result. If the cultivation produces very rapid and extensive tuberculosis, I say that it is much more virulent than in another case where the progress is slower, and the disease apparently more localized.

661. Can you give one or two examples in which the tuberculous virus appeared to have been attenuated ?—Yes, I am able to mention several examples.

662. Perhaps it would be better to give the results of your experiments in a general way ?—In a general way, the result is this: Human tuberculous matter introduced by inoculation, or by feeding rabbits, produces tuberculosis of a very slow kind. The tuberculosis is limited to the lungs, and one or two nodules appear, whereas in the case of bovine tuberculous matter introduced by injection or food, the disease makes very rapid progress, and is disseminated with extreme rapidity over all the organs. In a guinea pig the introduction both of human and bovine tuberculous matter produces general tuberculosis, but the bovine matter produces it much more rapidly than the human. It is a curious thing that when a guinea pig has become infected with bovine matter, and the infection is transmitted from the diseased animal to another guinea pig, the difference between the effect of infection by bovine and human matter becomes less. It appears in some way to equalize itself.

663. That is a characteristic also of other diseases, is it not ?—Yes, but the difference in feeding experiments in connexion with rabbits, between the virulence of the infection from human and bovine tuberculous matter, is sufficiently striking.

664. It has been suggested that protection might be given by the inoculation of the virus from tuberculous animals. Can you give any reason for thinking that that would not be the case ?—I have made a good many experiments within the last two years upon that subject. I had a large number of *tubercle-bacilli* introduced into a nutritive medium (Agar glycerine beef infusion), which is well known to be a good substance for producing growths of *tubercle-bacilli*. All who have worked with such cultures have noticed that after a lapse of time the virulence of the *tubercle-bacilli* wore off. I had a large number of guinea pigs infected with such cultures without producing general tuberculosis. I inoculated directly into a vein of a rabbit with the virulent material, when the disease became perceptible in 14 days, and the rabbit died from acute tuberculosis. I have here with me some of the slides which show the results of the experiments. This one, for instance (*producing a glass slide*) shows the lung of a rabbit operated upon in this way, which died in 14 days, in consequence of the development of tuberculosis in the lungs. You will perceive that all the giant cells are filled with *tubercle-bacilli*, whereas other cultures of longer duration when inoculated into the same class of animal was observed to be very much less virulent in its operation. There were distinct tubercular changes to be found in the glands at the seat of inoculation, but they did not lead to tuberculosis in the lungs, liver, and spleen. The typical sore was always there, but it healed in a few months, and the animal appeared to all intents and purposes to be healthy, and to have recovered. In a large number of cases, however, all the animals inoculated afterwards again with virulent material succumbed to general tuberculosis. That is the only experience I have had in regard to a number of animals which have been infected with localized tuberculosis. In every case the matter selected for inoculation contained *tubercle-bacilli*, but as I have pointed out the whole process ultimately passed away in many cases without injuring the animals infected, whereas these animals re-inoculated with bovine matter were more actively affected, and all succumbed.

665. No one else has, I believe, made any experiments except you ?—I believe that in Paris similar experiments have been made.

666. You have not the slightest doubt as to the great danger to the public health which arises from the general use of milk taken from tuberculous animals ?—I should think that a considerable amount of danger is incurred.

667. Is there any circumstance in connexion with this subject which it occurs to your mind to suggest ? —I do not think so.

668. In a lecture of yours, from which I read quotations in one of the journals, a reference is made to the regulations used by the Jews as to meat; can you give us any information upon that subject?—Only in a very general way.

669. Can you state what the essential point is as to the mode of regulation ?—I can only say what it is in my native town, in South Hungary. The Jews there have their own slaughter-house. They have a special inspector, who is required to inspect all the animals that are slaughtered, be they fowl, goat, sheep, calves, or oxen. He searches the lymphatic glands, pursuing his investigation almost by routine. If he finds that the glands are large and suspects that nodules are developed in them, he condemns the animal at once.

670. Without notice ?—Yes, without notice. He acts upon his own authority.

671. And without knowing what is actually the matter with the animal inspected ?—Yes, without knowing anything special about it.

672. Do you believe that that is an effectual system of inspection ?—Yes, I believe it is very effectual.

The witness withdrew.

Dr. A. Dawson Williams, M.B., Diploma of Public Health, Cambridge; Surgeon in charge of the Public Hospital, George Town, Demerara.

Dr. A. D Williams, M.B.

673. (*Chairman.*) You have, I believe, Dr. Williams, been for some years in the colonial service ?—Yes, for 13 years.

674. All within British Guiana ?—Yes, as district medical officer, medical inspector, and in my present post.

675. What is the population of British Guiana ?—Nearly 300,000.

676. Have you a general knowledge of the medical condition of the colony and the condition of the inhabitants ?—Yes, I have.

677. Is it within your experience that there is a great deal of consumption among the inhabitants of British Guiana—I mean consumption in the popular sense of the word ?—Yes, there is a great deal of consumption.

678. Both among the whites and among the Negroes ?—There are not very many whites in British Guiana. The white element forms only a very small portion of the population of the colony. The bulk of the inhabitants consists of Negroes and imported East Indians.

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679. What proportion of the total population of 300,000 consists of imported East Indians?—I should say very nearly 100,000 are East Indians, either imported or born in the colony. The other two-thirds are mostly composed of Negroes and persons of mixed blood. There are only, I think, out of the entire population, less than 2,500 whites.

680. Then in giving us your experience as regards the existence of tuberculosis or consumption in the colony we may assume that you are speaking, generally, of Negroes?—Negroes and Coolies.

681. Do you think that tuberculosis is on the increase in the colony?—I have no recent figures tending to show that, but it is the general impression that there is much more consumption now than there used to be, say 50 years ago.

682. That is your general impression?—Yes.

683. Is that due to the fact that the Hindoo population has been a comparatively recent importation?—The Hindoo population is affected very much, but apparently not so numerously or so severely as the Negroes.

684. Let us take the Negroes first. As compared with the European population, such as the French or English, are you able to say how much more in proportion consumption is rife among the Negro population of British Guiana than it is here?—Of course, I am aware that consumption in England is very common, but I think the proportion with us is even larger.

685. Larger in proportion than consumption in this country?—Yes, I think so. There are, for instance, nearly 1,000 deaths annually in the hospital of which I have charge.

686. Among the Negro population?—No; the total deaths are, roughly speaking, about 1,000 every year; of these about 25 per cent. are from phthisis and acute tuberculosis, as is shown by the *post mortem* examinations.

687. What are the habits of the people who die of consumption in British Guiana?—They live for the most part in small and badly ventilated dwellings.

688. Are they large consumers of meat?—No; the Hindoos especially eat very little meat of any kind.

689. What is the meat they mostly eat?—A few of the lower caste Indians eat pork, and occasionally the flesh of goats.

690. The Hindoos?—Yes.

691. But what do the Negroes eat?—They eat very little meat either. The principal meat they eat, but which they take only in small quantities, is salt beef and salt pork, imported from America.

692. How do they catch their consumption do you think? How do they contract it?—I think that in the majority of cases it must be by inhalation, through the lungs.

693. They contract it by inhaling the infection from each other?—Yes, and the predisposition to contract it is increased by the close and ill-ventilated atmosphere which they breathe.

694. Yes, but according to modern notions the bad condition of the atmosphere will not give consumption unless it is tainted with consumptive matter?—Precisely so.

695. Does it come out of the ground or from consumptive people who have been there before?—My own opinion is that in the larger number of cases the disease has probably been contracted by inhalation of products of previously existing cases.

696. Has it been the case, in all time, that Negroes have been particularly susceptible to consumption?—I do not know, so far as their own country is concerned, to what extent they are liable.

697. I mean in the history of the colony of British Guiana?—The general impression is that there is more consumption now than there used to be formerly.

698. Is it your opinion that it goes on *de crescendo*, being communicated from one person to another?—I think that is quite possible.

699. Is it your opinion?—My opinion upon any point connected with the subject would be given as to the probability. I do not think we are yet in a position to say absolutely what is the mode of origin in any given case.

700. Am I to take it from your previous answers that, so far as your experience goes, whatever may be the cause of the growing consumption, or the increased consumption among the Negro population of British Guiana it does not arise from the eating of tuberculous meat?—Apparently not.

701. Because whatever meat they do eat, and that is very little, is salted?—Yes.

702. And it is imported from abroad?—That is so. The salted meat is not cooked beforehand, but is usually cooked very effectually by the Negroes themselves before it is eaten.

703. Now, with regard to the increase of the disease: you say it is the general opinion that the tendency to consumption is increasing in the colony?—I will not say that. I only say that it is the general opinion that it has increased.

704. That it has increased?—Yes; that there is much more than there used to be.

705. You think that that is the case?—I cannot say within my own experience.

706. In the 13 years during which you have been in the colony is there more of the disease than when you first went there?—I cannot say positively that that is so.

707. Do you not think that it has increased?—Yes, I think it has.

708. Are the conditions of life among the Hindoos who have been more recently subjected to the character of the climate of the colony than the Negroes, different from what they were accustomed to? Did they come under any new conditions of existence when they were planted at British Guiana which would account for their being subject to tuberculosis to a greater extent than in their own country?—I do not know positively what the nature of their condition was in their own country, but I suppose that it would be somewhat similar. They sometimes build houses for themselves, which, I suppose, are something like the houses they had in their own country. They are much better ventilated than the houses which, as a rule, are provided for them on the sugar estates.

709. Do you find from your intercourse with them that they complain of a tendency among their family and friends to become consumptive?—No.

710. They do not take notice of it among themselves?—No, I do not think so.

711. Does the disease among the Negroes more particularly affect adults or young people and children?—It is very frequent among young people of all ages up to adults; children, young people, and young adults.

712. Taking the children, are they great consumers of the milk of cows?—Not to any great extent.

713. They are, as a matter of course, brought up upon milk?—Not as a matter of course; they do not take as much milk as is probably taken by children in England, and certainly not so much as they ought to do.

714. That is always supposing that it does not give them this disease?—Just so.

715. Is there plenty of milk to be had, and cheap?—It is not particularly cheap.

716. You should not say that the children are brought up largely on milk?—No, I should not.

717. Does the character of the disease vary at all from what you have been accustomed to observe in this country as far as you know?—It varies in this respect, that among the negroes there is a larger proportion of acute cases. The disease pursues a more rapid and acute course.

718. Are they suddenly attacked as if they had contracted an infection, or do they gradually deteriorate in health as we observe in this country among young children who frequently have a tendency to contract consumption?—The negroes frequently contract the disease in the manner you have described—rapidly and it takes the form of an acute infection.

719. As though they might have been poisoned by microbes?—Yes; in the same way as if they had

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contracted an infectious fever. On the other hand, the coolies almost invariably get the disease in the form in which it is well known in England; there is a less rapid breaking down of the constitution.

720. If a healthy person became suddenly attacked by consumption from tuberculosis, would you expect to find that he had been living in a cottage where other people had had it before him?—I should be surprised to find that he had contracted it without having come in contact, in some way or other, with persons who already had it.

721. Did you ever hear of tuberculosis being contracted from infected animals slaughtered for meat in British Guiana?—I am not aware that any observations have been made which show that to have been the case.

722. But the meat consumed is principally salted beef and salted pork brought over from America?—Chiefly; they eat very little but what is brought over in that way.

723. (*Dr. Buchanan.*) Did I understand you to say that there is very little slaughtering of animals for food in British Guiana?—There is very little; I cannot tell you the exact quantity of cattle bred and slaughtered in the Colony for food or brought from the neighbouring country of Venezuela and used as food.

724. (*Chairman.*) Who eats it?—The whites and the better class generally. There are a number of Portuguese, who are shop-keepers principally.

725. Do they suffer more than other people from tuberculosis?—They do suffer from it, but I cannot say that they do so in greater proportion than other people, or, indeed, what the relative proportion is.

726. (*Dr. Buchanan.*) Have you any knowledge of the usual state in which the organs of animals slaughtered for the purpose of food are found?—No, I have not.

727. Can you tell us whether you have noticed any difference between the prevalence of tuberculosis among coolies and negroes living under the same conditions; where you have ascertained the conditions to be similar?—The conditions in which they live are not very different. They frequently live together on the sugar plantations, and when they live in the free villages they live together in the same way and under the same conditions largely.

728. There is no difference between them?—No, except that the coolies may be more associated with cattle than the negroes are. They are much fonder of cattle.

729. (*Chairman.*) Do they handle them and live with them?—Yes.

730. And yet on the other hand they are not as much affected by consumption as the negroes are?—I do not think I have said that.

731. I thought you began by saying that the Hindoos in regard to infection by tuberculosis did not suffer as much as the negroes?—What I meant was, that they do not suffer as much in intensity.

732. (*Dr. Buchanan.*) It is a slower form of disease?—Yes. With regard to the relative number of cases I think I can supply you with an indication, although I have not got the figures with me and I am unfortunately away from all sources of information, I think, however, that I can give you an indication. There were about 1,000 deaths in the public hospital with which I am connected last year, and 400 of them were among the coolies; but whether the deaths from phthisis and tuberculosis generally were in that proportion I am unable to say without referring to the records.

733. (*Prof. Sanderson.*) Which class is best off; the coolies or the negroes?—They are about the same. Most of them are labourers who work for subsistence, but there may be a few among them who are persons of small means who may have accumulated property.

734. (*Dr. Buchanan.*) Could you forward to the Commission, on your return, such figures and facts or records on the subject as you think would interest us. If you can collect them we should be glad to have them from you?—With the permission of the Surgeon-General of the Colony I should be glad to furnish the Commission with any statistics that are obtainable.

735. (*Chairman.*) We shall be glad if you will be good enough to send us anything you can, showing, as far as you can ascertain it, how far the suspicion as to the growth of the disorder, and the increase in the number of cases, is justified by the actual facts?—I will endeavour to do so.

736. (*Dr. Buchanan.*) In the cases where you have examined the organs of the body of a person who has died from tuberculosis, are you able to say whether the disease was more local and less general in one class of cases than in the other. What organs appear, in the majority of cases, to have been primarily affected; where would you take the earliest invasion of the tubercles to have been?—Frequently the lung is apparently the only organ affected, in other cases, where other organs are affected, and general tuberculosis is present, the disease in the lung usually appears to be in a later or more advanced stage than the disease in the other organs.

737. Have you frequently found the intestinal canal ulcerated or infected with tuberculous matter?—Yes, frequently.

738. Do you think that would be an earlier or a later stage than the lung infection?—Where there is an extensive ulceration of the intestines I should not like to say. It needs a further study of the materials we have before one could give an opinion as to what appears to be the primary source of the disease in such cases, but there are many cases in which there is an extensive infection of the peritoneum and liver, spleen and kidneys, without much ulceration of the intestines, in which the presence of tubercles would appear to be quite recent as compared with the disease in the lungs.

739. I had intended to ask you some questions in regard to the more rapid development of tuberculosis which you have witnessed among the negroes, but as you propose to place before us some facts in regard to the way in which one class is affected by the disease, I presume you will probably give us facts also in regard to the other class?—I shall be glad to do so.

740. (*Dr. Sanderson*). Is milk consumed to any extent by either class?—I think the coolies take a good deal of milk.

741. The coolies?—Yes.

742. More than the negroes?—Yes. Both take milk to some extent, but I think it is usually the case that the milk is boiled before it is used.

743. That is usual?—Yes; owing to the climate it would soon turn, and therefore as a rule it is boiled.

The witness withdrew.

The following letter and report were received by Sir George Buchanan for the information of the Commission:—

Public Hospital, Georgetown.
British Guiana.
May 2, 1891.

Sir,

I have the honour, by permission of the Surgeon-General of the Colony, Dr. Grieve, to forward to you, for the use of the Royal Commission upon Tuberculosis, the notes and statistics which I was asked to furnish when last in England.

The delay which has occurred since my return has been occasioned by the necessity for the collection of a fresh series of cases taken without selection. I now forward the notes of these, with others, and trust that if found to be of any service otherwise, they will not arrive too late.

I have the honour to be,
Sir,
Your obedient Servant,
A. D. Williams.

George Buchanan, Esq., M.D., &c.
Med. Officer, L.G.B.

Dr. A. D. Williams, M.B.

2 May 1891.

Notes upon Tuberculosis in British Guiana.

Of pulmonary phthisis and other forms of tuberculosis, there is much in the Colony, and it occurs among all the large variety of races represented here.

Though the line between tuberculosis pulmonum, and chronic pneumonias and bronchitis, may not always be distinguished clinically, yet the table (Table I.) shows that the absolute number is large; that its mortality bears a large proportion to the total mortality, and that any reasonable transfer of cases from the former to the latter categories would not greatly affect the significance of the figures.

Many of the cases were verified by the demonstration of Koch's bacillus, either ante or post-mortem. In many cases the examination was not made, and in some, careful examination failed to show the bacillus. It is quite possible, therefore, that there may be cases which present the gross characters of tubercle, but in which the infiltration and destruction of tissue may be the result of the presence of other known or unknown parasites. Of these the actinomyces especially has been watched for, but not found. From Table I., however, it appears that about 25 per cent. of the total number of deaths in the Public Hospital, Georgetown, have been for several years past referred to pulmonary phthisis and tuberculosis.

The proportion of deaths to cases treated is not of much significance, inasmuch as the people are apt to go in and out very much, especially the more chronic cases. For the same reason no definite conclusions can be drawn from an examination of the duration of cases as recorded. It often happens that while a case (especially, as has been remarked by the Surgeon-General, in the black race) may come in at an early stage, run an acute course like a specific fever, and be terminated by death in a few weeks; another may last for years, come in and go out repeatedly, and perhaps finally terminate in a few days, or even hours, after the last admission.

From the results of post-mortem examinations, however, some information may more easily be reached.

The record of those made at this hospital for the year 1890 shows that while 539 necropsies were made, in 113, or 21 per cent., tuberculosis of lungs alone, or of lungs and other organs, was found to exist.

These were distributed according to race, as shown in Table II.

On careful examination, however, these figures do not appear to correctly represent the proportion of deaths in relation to race; as, while the whole number of necropsies is less than one-half the whole number of deaths for the year, the more chronic cases among the East Indians have been omitted in larger proportion than the more acute cases among the blacks.

In Table III., therefore, is given the race distribution of the tuberculous cases occurring in four successive series, each of 100 consecutive post-mortem examinations; the whole comprising all the deaths (with a very few unavoidable exceptions) which occurred in the hospital between December 13th, 1890, and 23rd March, 1891. Beginning in December, as it does, the 1890 series overlaps this latter by 15 cases, which are included in both.

It should be observed also that the latter series extended over a period which was one of an excessive mortality rate from other causes, thus diminishing the tuberculous rate, which nevertheless still stands at over 26 per cent. of the total mortality.

Of this number, 2 per cent. occurred in whites, native and European, and Chinese; the remainder being nearly equally divided between immigrant East Indians on the one hand, and natives of black and mixed races on the other. One only aboriginal Indian occurs in the united series.

An analysis of the anatomical distribution of the disease in the first series (omitting the 15 cases included in the second series) is given in Table IV.

This shows a large percentage in which intestinal disease was present, the cases in which the mesenteric glands were affected alone or together with the bowel not being separately noted. There is also a large proportion of cases in which the kidneys, spleen, peritoneum, and cranial meninges were the seat of tubercular growth, a proportion greatly due to the selection of complicated cases for post mortem examination.

Table V. embodies a similar analysis of the consecutive 107 cases in which there was no selection. In this the proportion of cases in which the solid viscera and membranes were attacked is much less than in the selected series; but, on the contrary, the percentage of intestinal cases is considerably higher, being nearly 50 per cent. This difference is probably caused by the selection in the former series being influenced by the more pronounced symptoms attending peritoneal and meningeal tuberculosis, while the intestinal affection is chiefly marked by diarrhœa, a common general symptom; or it may be fortuitous simply, the series not being large enough to eliminate this possibility.

Taking the combined series of 205 cases, in two only were the lungs unaffected, tubercle at the same time growing freely in other organs; while in two others only the evidence of former disease was found, and no growth noted elsewhere.

In one of the cases, in which the lungs were not affected, copious tubercular deposit occurred in the pleuræ, the pericardium, and the mesenteric glands; in the other case, a copious deposit in the peritoneum only. One other case showed a pericardial growth, the solitary aboriginal Indian, and in this case both lungs, the small intestine, and kidneys were also affected.

It is interesting to note that in the two cases in which there could have been no expectoration of infective material, there was no infection of the intestines, which was also the case in several others, in which the lung diseases existed in the miliary form, without caseation or cavities. This, however, may be coincidence only, for which the facts offer sufficient opportunity.

The figures, however, comprise other points not without significance, when taken in conjunction with the habits of the people, to be presently referred to in regard to the much discussed and immensely practical important question of the modes in which natural communication of the disease takes place.

The nearly universal occurrence of the disease in the lungs, and the large proportion (36 per cent.) in which the lungs only were affected, indicate that the parasite often gains access by means of the respiration, or that if otherwise introduced it finds more favourable conditions in those organs. The latter hypothesis is weakened by the facts that in some cases many tissues were affected while the lungs escaped. On the other hand, the concurrence of the disease in the intestine in nearly 50 per cent. of the cases, taken in connexion with the fact that the people consume fresh meat and milk sparingly, or not at all, and in all cases well cooked or boiled is also significant. It is remarkable that the East Indian coolics who, except in hospital, refrain from eating flesh almost entirely, or at most eat only the insusceptible goat-flesh, should yet have suffered from the intestinal form of the affection in 49 per cent. of their cases, while the remainder of the races were similarly affected in a little over 48 per cent.

The following outline account of two typical cases now in the phthisis wards will illustrate what has been said:—

Siniybally, East Indian, age 30, male, has lived in this country for 20 years. Has had cough for three years; about that time he began to get slight cough, and pains in top of his chest. The first year he felt sometimes better, but the last two has always felt bad and had cough. Has now extensive disease on both sides, with cavities; is fairly well nourished, and is stronger and has less pain than some months ago. Questioned as to diet, he says that he "eats flour-cake, peas, rice, "butter, and curry; milk seldom, except when he had "a cow, and then always well boiled. Never ate beef "in his life; sometimes ate goat-meat when his friends "made a feast."

Richards, age 28, black native of British Guiana. Was quite strong and well till three months ago, when he began to get fever and pains in his chest, and then began to cough. The cough is getting worse; is now emaciated, disease in advanced stage; sputa swarms with bacilli. Used to eat plantains and sweet potato, bread and sugar, salt fish; sometimes fresh fish and shrimps, split peas, and barley. Salt beef in soup, about ½ lb. for six people. Often had fresh beef on Sunday, usually had it fried. Seldom ate fowls. Mother is living; father died at 49 years.

A. D. Williams, M.B., &c.,
D.P.H. Cambridge,
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TABLE I.

Cases and Mortality; Public Hospital, Georgetown, British Guiana.

——	1885.		1886.		1887.		1888.		1889.		1890.	
	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.
General - -	5,960	898	7,366	753	9,521	970	6,645	996	6,730	932	8,566	1,216
Phthisis - -	317	140	836	206	753	273	437	250	534	212	517	253
General tuberculosis	—	1	8	15	17	17	25	23	18	32	53	30
Pneumonia - -	51	29	116	57	148	40	91	29	118	51	232	97
Bronchitis - -	217	48	167	3	310	1	166	9	162	11	123	8

TABLE II.

Post-mortems, 1890: Distribution by Race of Cases of Tuberculosis.

Whole Number of Post-mortems, 539; Cases of Tuberculosis, 113.

Black.	White.	Chinese.	East Indian.	Mixed.	Aboriginal Indian.
57	7	1	34	13	1

TABLE III.

Four Series Consecutive Deaths of 100 each.

Whole Number of Post-mortems, 400: Cases of Tuberculosis, 107.

——	Black.	White.	Chinese.	East Indian.	Mixed.
1st 100 -	11	—	1	11	4
2nd 100 -	8	2	—	11	3
3rd 100 -	9	2	—	16	3
4th 100 -	11	3	—	9	3
Total -	39	7	1	47	13

	TABLE IV. Anatomical Distribution of Cases, Table II.	TABLE V. The same, Table III.
Lungs and bronchial glands —		
One apex -	3	9
Both apeces -	5	4
One base -	—	6
Both bases -	1	3
One lung -	1	10
Both lungs -	86	75
Not in lungs -	2	—
Lungs only -	39	35
Small intestines with or without mesenteric glands -	36 (14 East Indians).	52 (23 East Indians).
Peritoneum -	17	3
Cranial meningis -	9	2
Pericardium -	1	2
Pleura -	3	3
Liver -	8	10
Spleen -	13	18
Kidney -	15	10
Bladder -	1	1
Bones and joints -	—	2
Whole number of cases -	98	107

Adjourned until Wednesday, November 5th, at 2.30 p.m.

SEVENTH MEETING.

7, Whitehall Place, S.W., Wednesday, November 5th, 1890.

PRESENT:

THE RIGHT HON. THE LORD BASING PRESIDING.

Professor G. T. BROWN, C.B.
Dr. J. F. PAYNE.
Dr. G. BUCHANAN, F.R.S.
Professor J. BURDON-SANDERSON, F.R.S.
Mr. LEOPOLD HUDSON, *Secretary*.

Dr. EDWARD EMMANUEL KLEIN, F.R.S., recalled and examined.

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744. (*Dr. Buchanan.*) I have a few questions to put to you, Dr. Klein, from the point at which you left off when you were last examined. I think we ought to know, in the first place, what the diseases are which the doctors commonly understand when they speak of consumption of the lungs in a human subject?—Do you mean besides tubercular consumption, besides tuberculosis?

745. Yes?—In the first place there are the results of the pneumonias: Every kind of pneumonia which is not generally spoken of as tuberculosis. Croupous pneumonia, for instance, leads sometimes to suppuration and in time to a great destruction of lung tissue. Another result of pneumonia is gangrene. Another result is what the pathologists call cirrhosis or simple cirrhosis. Then, again, there is the septic processes in the lungs leading to the formation of abscesses. That is also called consumption, and is a destruction of lung tissue. In addition there is a large group of diseases known as bronchial pneumonia, a considerable portion of which lead to the process of suppuration and of that particular kind of wasting which is spoken of as a serious disease of the lungs. This bronchopneumonia practically plays an important part in setting up prolonged bronchitis, which to a certain extent may lead to those processes which may be called consumption.

746. As regards the pulmonary diseases which are connected with dust processes among file makers and stone-cutters, are they tuberculosis, or would you range them under the other heads which you have spoken of?—I should range them under the head of bronchopneumonia, or as one or another kind of bronchopneumonia.

747. They are not necessarily tuberculous?—Not necessarily.

748. But in your opinion they may become tuberculous?—There is, I believe, a class of diseases connected with the manufacture of hats, in which a large per-centage of the persons engaged in the manufacture are subject to tuberculosis. That probably would be put down as being due primarily to pneumonia, and as being set up by inhaling the dust of the work in which they are engaged.

749. Can you form any estimate of the per-centage of cases among phthisical people that is really tuberculous in character?—No; I could not do that, I have no particulars of that kind to base an opinion upon.

750. Can you give the Commission any approximation as to the number?—No, I should not like to express any decided opinion.

751. You would not like to say?—No, certainly not.

752. Then as to the cases which you would regard as tuberculous phthisis, they are cases which always require bacilli to have been introduced into the body?—Yes, I should only call a disease tuberculosis when I had clear evidence, either microscopically, or as the result of experiments that *tubercle bacilli* existed.

753. How far is there any distinction in form between the tuberculosis with which animals are infected, and that which infects man?—I am not able to tell you that.

754. Can you tell us whether there is any difference, so far as different kinds of animals are concerned, in their liability to become infected with tuberculous disease?—It is well known that the bovine species is a species which is particularly prone to tuberculosis. Next come pigs, I should say. Then sheep, and, as far as experimental evidence can ascertain, rabbits and guinea pigs are known to be highly susceptible to the disease. But as to how far these animals are naturally subject to the disease is a question upon which opinions differ. It is comparatively recently that it has become known that certain deposits, say, in the liver or spleen of rabbits and guinea pigs, which used to be regarded as tuberculous, are not really tuberculosis, but a disease which is now known under the name of pseudo-tuberculosis, due to a different order of things altogether. Then, again, I should say that fowls and poultry generally are susceptible to a disease which many persons regard as tuberculosis. It is chiefly a disease of the abdominal viscera which manifests itself in the liver and particularly in the spleen. Deposits are formed which undergo caseation and, as far as microscopic observation and experiments go, they are of the same class as those which constitute tuberculosis. But I ought to point out that although fowls may be rendered tuberculous, experimentally, by infection there is a natural disease in fowls which, although it is generally pointed out as tuberculous, is not the ordinary tuberculosis. It differs in certain respects from tuberculosis, and particularly in the cultivation of the bacilli, and it does not show the same marks as tuberculosis in the human or bovine species. The same remark applies to other birds, the experience in regard to which has been chiefly derived from observations which have been made in the Zoological Gardens. It is well known that in the case of animals a considerable per-centage succumb to attacks of tuberculosis, and that is the case in the Zoological Gardens in London among the birds and other animals, or even among the monkeys. It has been shown that monkeys are particularly subject to tuberculosis.

755. (*Chairman.*) You are speaking of tuberculosis, I presume, and not of consumption of the other sort?—I am not speaking of consumption of the other sort. A large number of monkeys have died at the Zoological Gardens, and not from tuberculosis.

756. Would not the Zoological Gardens be an easy place in which experiments could be carried out? Surely if they died there under circumstances which precluded the possibility of their getting infection from the person itself, would it not have a tendency to show that tuberculosis arises from inhalation?—I should not like to say that that would really be a test experiment.

757. What I mean is an experiment of this nature. If you find that the monkeys in the Zoological Gardens remain perfectly healthy, but that other animals die in the same proportion as they do now,

under other conditions might not an inference be drawn?—I should not like to go back upon what I know to be the fact, and I do know that a good many animals do die of tuberculosis, which is also the case in regard to the monkeys in the Zoological Gardens.

758. (*Dr. Buchanan.*) Are you able to tell us the different order of susceptibility to tuberculosis in different animals? What is the order in which animals are more readily infected?—Well, I should place cattle first. Then pigs, sheep, and fowls, but I can only speak in regard to the artificial production of the disease. There are certain animals which we know to be extremely susceptible to tuberculosis.

759–61. Upon what do you base that opinion?—I find in regard to the Berlin slaughter-houses that a large number of cattle and a considerable amount of tuberculous beef are condemned, but there is no record kept of a single sheep or a single piece of mutton being condemned on account of the existence in it of *tubercle bacilli.* Do you think we may infer from that fact that there are no tuberculous sheep and no tuberculous mutton in the Berlin slaughter-houses?—I should rather say that mutton does not form as large a per-centage of the food of the people in Germany as it does here generally. I do not know what the percentage is exactly, and I only speak from general knowledge. I have a report here which gives a return of 115 cattle and only 13 sheep. That shows that there were only a very small number of sheep infected with the disease in comparison with cattle.

762. (*Chairman.*) Is that a report of animals that were condemned?—Yes.

763. To what year does that report apply?—To the year 1883–84.

764. I have here a report of the cattle sent into the Berlin market in 1889. The number appears to have been 430,000, and the number condemned were 1,397. In addition there were 30 calves, 5 sheep, and 1,600 pigs. The average slaughter of cattle was 150 per day. The return does not say that any meat was condemned?—I notice that there were only five sheep.

(*Dr. Buchanan.*) The return appears to relate to the whole animal.

(*Chairman.*) Yes.

765. (*Dr. Buchanan.*) Here is another statement in the report that parts of certain animals were allowed to be used while other parts were proscribed?—The report says, cattle, 21,000; calves, 86; sheep, 4,800; pigs, 7,400; and as regards tuberculosis it does not mention sheep at all.

766. A little lower down, I think, you will find that tuberculosis is taken into consideration?—It says that tuberculosis has been observed in various stages of development in 2,613 cattle, 2 calves, and 1,313 pigs. The report does not mention sheep.

767. That is just my point. You see that we get no mention of sheep?—That is so.

768. Then there might be a considerable amount of tuberculosis among cattle, without sheep being infected by the same disease?—I think it is a well established fact that sheep are much less infected by tuberculosis than cattle. Then again, there is another point. It is not uncommon to meet with deposits in the lungs of sheep which are really not tuberculous. I suppose that deposits of that kind are not included in the enumeration given in the report. It is a matter which is perfectly well understood in Berlin.

769. You do not think that the difference is only a difference in the inspection and practice?—I do not think so. I can hardly imagine that there would be an omission to take notice of the existence of the disease if tuberculosis really existed.

770. Have you any information as the frequency of tuberculosis among cattle in open pastures as compared with its frequency among cattle in sheds?—No, I have not.

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771. As a matter of fact tuberculosis does occur among cattle in open pastures?—Yes, I think so.

772. And in that case the cattle must have got the bacilli while pasturing?—Not necessarily. They may have got it while in the open pastures, but not necessarily.

773. They may have got it in the pastures?—Yes, they may have got it, but I should hesitate to say that either many or few got it in that way. There is a possibility that they may have got it while pasturing; but there is another probability which is more likely, namely, that they may have inherited it, and that it only manifested itself after they had reached a certain age.

774. Supposing that there were conditions which gave tuberculosis to cattle in the pastures, would the presence of those conditions affect the sheep that were pastured with them?—I should say that the conditions would affect sheep less than cattle, because sheep are less susceptible than cattle to be infected by tuberculosis.

775. The sheep would not contract the disease?—No, I think not.

776. Is that because in the case of sheep there would be wanting what I may call a predisponent condition in themselves?—Yes.

777. There might be something possessed by the cattle which would not be possessed by the sheep?—Yes; but the same thing can be said of other animals, for instance, dogs and cats. They can be infected by active virulent tuberculosis, but we know that it is a very rare thing indeed to find them naturally tuberculous. I have seen it in cats, but very rarely as compared with tuberculosis in cattle.

778. Can you tell us anything of the nature of the condition which renders cattle more liable than sheep to infection by tubercle as compared with sheep?—I cannot tell you anything distinctly as to what we call predisposition, but I may say in a general way that there may be a predisposition to contract the disease in the same way as there may be a predisposition to contract other diseases.

779. Suppose that you were to inoculate sheep with the *tubercle bacillus,* would they take the disease as readily as cattle?—I have not made many experiments in that direction personally, but there are some on record which seem to show that they will take tuberculosis, but will not develop it with so uniform a result as cattle or other animals.

780. Can you tell us anything about calves? Have you noticed in the report in reference to the Berlin slaughter-houses that calves are not found to be infected by tubercle in the same manner as the older cattle?—That is so.

781. Is that because the calves have not been allowed to remain alive sufficiently long to show the tubercle?—Yes; I should say that that is very possible.

782. They may have been slaughtered before the tubercles had assumed any conspicuous proportions?—I am inclined to think that a large per-centage of calves do have some kind or other of deposit which may be easily overlooked, but which there is no doubt is tuberculous. There may be a sort of latent slow form of tuberculosis. I know it is stated that very few calves indeed show tuberculosis, but I am inclined to question that statement.

783. You do not agree with it?—No, and there are others who have paid attention to the subject in Germany who are of opinion that if the proper examination were made tuberculosis would be found present in a certain percentage of calves in the mesenteric glands or the spleen. The disease is not developed rapidly, but I think it is justifiable to say that if time were given to the calves to grow up into adult cattle they would develop it, and that the disease would make the same kind of progress as tuberculosis in cattle generally.

784. You think that when they became adult cows or oxen they would develop tuberculosis?—Yes.

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785. And that tubercles would be recognised in older cattle, whereas in calves they would be less readily recognised?—Yes; there have been many cases in which calves a few weeks after they have been slaughtered have shown that there has been a distinct process of tuberculosis going on. I have had an opportunity since I was last here of looking up various statements on this subject, and I found that there have been observed tubercular deposits in the mesenteric glands, the spleen, and other organs of young calves. I think it is a fit subject for Professor Brown to take up and make a record of. I do not think that, so far, sufficient attention has been paid to it. I know that in my own case the matter would have been passed over if my special attention had not been drawn to it by my assistant. On making *post-mortem* examination of various calves he pointed out to me now and again a small nodule which on examination I found to be tuberculous. It might have been missed owing to the fact that it was not conspicuous, and it might have been easily overlooked. I do not say that this would be found to be the case in every instance; but it is a matter that is well worth examination. I believe I am correct in saying that hitherto there has been no systematic examination made.

786. I think it is important as bearing on the transmission of tubercle to calves from their mothers?—Yes; some think the same thing applies to sheep also, which undoubtedly have tuberculosis, but are not infected to the same extent as cattle. I fancy there must be cases in which the existence of tubercles may be found, although they may not be very conspicuous. The process in sheep, is, as I have stated, much slower and less extensive than in cattle.

787. If in the case of calves the signs are so obscure, have you been able to notice any facts which would lead you to the supposition that the tubercles may have come from the milk of the mother when suckling the calf?—In certain cases I should say that the infection could not have been acquired after birth, but that the calf must have been born with it. The calf was too young to have acquired it otherwise. The process does not advance in calves. It is under all conditions a chronic process, and I wish to emphasize my opinion that the infection could not have been acquired afterwards, but must have been inherited. I do not see how one can assume that in the case of so very young an animal caseous nodules could have been developed by the slow process which is involved in the development of these nodules.

788. Has any observation been made in regard to the cows which furnished the milk to such calves as you have been speaking of? Was there any evidence of tuberculosis?—I think that in many of the instances in which the calves were shown to be tuberculous, the disease was not traced back to their mothers. Those which did come under observation were killed, but I do not think any record was kept which would enable me to say that the infection had been inherited.

789. The connexion was not established?—No.

790. Besides the observation of the calves and the relation between calves and cows, is there any experiment you would suggest as being likely to throw light on the subject of the infection of animals from food?—First of all, you have to clear the ground of this difficulty—namely, you have to ascertain what is the percentage of latent tuberculosis in calves. Next it would be necessary to make experiments by feeding a series of calves with matter of a tuberculous nature, and ascertaining how they would be affected by it. In that way it is possible to get some idea as to how many would become infected with tuberculosis from feeding. At the same time I must add that the feeding of calves with *tubercle-bacilli* would not always of necessity lead to the development of tuberculosis in the alimentary canal. If it were so, and if it were always the case that the feeding of calves with tuberculous matter always resulted in the development of tubercles in the alimentary canal, there would be some ground to proceed upon. But such is against the results of other experience. I have myself published instances of experiments on fowls, rabbits, and guinea-pigs, where, after feeding them with tuberculous matter, tuberculous deposits have been found in the spleen and in the mesenteric glands, but not in the wall of the intestines; but I am not prepared to say that that is always the case.

791. Is there any habitat for the *tubercle-bacillus* outside the body?—The *tubercle-bacillus* is capable of forming and containing spores, although it cannot be demonstrated, even by the microscope, which are spores. We know, however, that, as a matter of fact, the infection does in some cases arise from spores. The *tubercle-bacillus*, like all other *bacilli* in a bacillary state, in 80 per cent. of cases, is destroyed by heat or drying, whereas, on the other hand, the spores do survive even heat of boiling water and drying. The experiments performed by Rash and others in regard to human sputum prove that in the sputum there may be *bacilli* present, not only in a bacilliary state, but also in the state of spores. So also in regard to the cultivation. We know that in heating and drying, in many cases, they do not lose their activity and life by those processes, and we conclude that there must be a form or stage of *bacilli* in the shape of spores, the character of which we have hitherto, unfortunately, had no means of ascertaining. Therefore, when you ask me if there is any habitat for the *tubercle-bacillus* outside the body, my answer is that that is quite possible, and that the spores may exist, even in multitudes, and would retain the power of imparting infection.

792. They would retain their life and activity?—Yes; they would retain their life.

793. Your reference to experiments suggests that they should be carried out under conditions which render it certain that no *tubercle-bacilli* can be accidentally present?—Yes, if the experiments are to have any value at all.

794. Can you give us any notion of the frequency of the presence of the *tubercle-bacillus* in the air of large towns? Are we to regard it as universal or not?—I should say that that is so in a large town like London, or in any large town where you have a number of phthisical patients distributing spores by their expectoration. I think there is a great chance of the spores of *bacilli* being present with dust in the air under such conditions.

795. Do you consider them perfectly ubiquitous in large towns?—Yes; but it would require certain conditions of atmosphere, &c. to enable them to exist in the air. But where there are spores—and we know that the *tubercle-bacilli* do contain spores—they will maintain their vitality. I ought to add to that statement one thing which we do know, namely, that sunlight has a very powerful effect upon *tubercle-bacilli.* In many instances it does kill even the spores. That would not be the case under other certain conditions; *e.g.*, in a room, or in a workshop, or in any other places where numbers of people congregate, and where a large number of spores may be distributed; of course, in such cases the remark as to the effect of sunlight would not apply.

796. Do you suppose that in the atmosphere we are breathing now there are *tubercle-bacilli* about?—I think you will see that that is a very difficult question to answer in a general way. My observation applied to places in which a large number of persons congregate, such as a large workshop. Among the persens so engaged you will always find some who are suffering from phthisis, and when that is the case you will find that the air always contains the *tubercle-bacillus.* What I mean is that in a confined space, if you have any person suffering from tuberculosis, you have may bacilli in the air.

797. Do I understand that your statement applies only to the conditions of the atmosphere indoors, and does not extend to the common outdoor atmosphere of towns?—Well, from what one sees in the streets in the shape of tubercular spectum being voided by

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phthisical persons, I should expect to find a good many tubercular spores about.

798. Referring to those bacilli which are able to cause tuberculosis in man and animals, you do not find necessarily that all animals and all men get tuberculosis from them ?—No.

799. So that there is a difference between one man and another man ?—Yes.

800. And one animal and another animal, so far as the susceptibility to contract the infection goes ?—Yes.

801. Is that in consequence of a difference in predisposition, as we have called it ?—Yes, I should certainly say so.

802. Can you help me in this. You have told us that one sort of predisposition exists in cattle as compared with sheep, and that one sort of predisposition may reside in one man which does not reside in another man ?—Yes.

803. Is there, in your opinion, any sort of relation between these two predispositions. You said, as I understood, that it might be practicable to account for the predisposition which oxen have towards tuberculosis over sheep. Is there anything that suggests itself to you which points out that there is a similarity between the two predisponent conditions ?—I do not quite understand the position.

804. You told us before that cattle and sheep discover a predisposition to become infected by tuberculosis ?—Yes.

805. But that cattle take it more readily than sheep ?—Yes.

806. And now you tell us that in man the same thing applies to different individuals of the same species. That one individual will be less predisposed to contract tuberculosis than another ?—That is so.

807. You say that some individuals differ from others as regards this predisposition to take tuberculosis, although they may be exposed to it in a common atmosphere ?—Yes.

808. Well then, I take it that there are two different kinds of predisposition ; one in the species, and the other in particular individuals of the same species ?—Yes.

809. Do you see any resemblance between the predisposition in the one case and the predisposition in the other ?—In using the word predisposition it can only be understood in a general way. If we had a more detailed knowledge of what the predisposition is, we might to be able to get nearer to an understanding. I should certainly say that the predisposition of one individual and that of another in the human species resembles in a certain sense the predisposition of one animal and that of another.

810. But we know very little about it ?—Yes, we know very little about it.

811. At any rate, whatever its nature is, is it not clear that the predisponent condition which determines whether an animal will get tuberculosis or not in the presence of *tubercle-bacilli* is an important factor, as important as the *tubercle-bacilli* themselves, for the production of the disease ?—Of course, all these are matters for consideration. In the first place there is the cause, and next there are the conditions which are favourable to the contraction of the disease. In this case, one of the factors is a predisposition to become infected by tuberculosis, and it is a factor of extreme importance. You may inoculate a field mouse with glanders and you will succeed at once, whereas you may inoculate a house mouse with glanders and you will not succeed. Therefore, I should say, as applied to a human being in connexion with tuberculosis, the existence of *tubercle-bacilli* in the atmosphere, or in certain other conditions, is not alone sufficient to cause infection. It may be in most cases the primary cause, but there is something else.

812. It is a primary factor necessarily involved in the production of tuberculosis ?—I should say so, certainly.

813. Some people tell us a great deal about *tubercle-bacilli*, and have given us details of bacterial life. I wish to ask you whether a tendency has not been evinced in these accounts to ignore the other causes and conditions which, in your opinion, are also necessary for the production of tuberculosis in the human species ?—I would not say that there is a tendency to ignore it altogether, but no doubt there has been a tendency to underrate it. But that is easily explained. The primary cause offers such a wide field for work that those who have been engaged in the investigation have not yet had time to pay attention to other questions and conditions. I suppose that that is the real explanation why the second part of the question, the predisposing conditions, has not yet been taken in hand.

814. It was inevitable, if the research was to be entered into, that it must be begun with what was seen most readily ?—Certainly.

815. Do not understand me to impute any neglect of the predisposing conditions, as matter of blame ?—Oh, no.

816. We were hearing the other day about injections into the peritoneum as one means of introducing tuberculous matter into the body. Can you tell us anything about the different methods which have been adopted for introducing *tubercle-bacilli*, and how far those methods affect the introduction of tuberculosis in the experiments which have been made ?—You are of course referring now to the inoculation of animals, and not of a human being ?

817. Yes ?—In the case of animals the methods which have been adopted in the experimental work have been by feeding, by inhalation, and by intraperitoneal and subcutaneous injections.

818. Intra-peritoneal injections ?—Yes ; but there have been intra-venous injections also. And I may add that of all the experiments the intra-peritoneal injections, and the injections into the anterior chamber of the eye, have been those which have yielded the most striking and positive results. Next come subcutaneous injections, which have given positive results also, but not so rapidly. The intra-venous injections have yielded good results, but not so rapidly as the others. I have seen cases in which the intravenous injections of artificial cultures of the *tubercle-bacilli* has produced acute miliary tuberculosis in the lungs of rabbits in 13 or 14 days. At the same time several of the experiments, although conducted entirely in the same way, have not been so successful. Then again there are the feeding experiments. That is a method which is also largely used, and which has given in most instances results comparable in regard to the production of general tuberculosis with the subcutaneous injections. With reference to the inhalation experiments, there has been a very great disparity in the results. Some of the experiments in a certain per-centage of cases have given positive results, but in other experiments no result whatever has been obtained. Perhaps that may be accounted for by the different methods which have been used for inhalation. Some of them went merely to the extent that they placed the animals in a condition in which there was a great deal of tuberculous matter about. These experiments have now been going on for something like 8 to 10 years, and the gentleman who has been engaged in making them, Dr. Baumgarten, maintains that not in a single instance where the animals experimented upon have been kept in stables or stalls where there were no tuberculous animals were positive results obtained ; whereas it appears that others did obtain positive results by experiments carried out under other conditions. In the latter case the method employed was to keep the animals in a confined space, and then to saturate the air with tuberculous matter. I myself put a number of guinea-pigs in cages in the ventilating shafts at the Brompton Hospital about 13 or 14 years ago. I kept them there for several weeks, and they were then removed to the laboratory in order to ascertain what the results were, and I found that all these animals were affected with tuberculosis. There is no doubt, then, that by inhalation the

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infection can be produced; but I should say that it is not frequently produced, under ordinary conditions, nor is the virulence the same. The other experiments, as I have already explained, have been intra-peritoneal, intra-venous, or subcutaneous. It is now perfectly well understood that what used to be called *cutaneous-tuberculosis* is really tuberculosis. For instance, the hands of those who have performed a large number of *post-mortem* examinations of tuberculous patients have become affected.

818*a*. (*Dr. Payne.*) I had an instance of that myself. But it is a well-established fact that in cases of that kind tuberculosis does not seem to make rapid headway. The same observation will apply to cooks, grooms, and butchers who have repeatedly shown the existence of tuberculous nodules in the skin. These nodules most distinctly contain the tubercle-bacillus, but they underwent a process of caseation, and the nodules disappeared.

819. (*Dr. Buchanan.*) Does it make any difference whether the matter is taken from localised or disseminated tuberculosis?—I should say that it does. In the latter case there may be a large amount of virulent matter, whereas in the former the matter would be much less virulent.

820. If you used the *tubercle-bacilli*, from nodules such as you have spoken of in the skin of butchers, would you expect to get a different kind of tubercle in the animal experimented upon?—It would depend upon the animal I experimented upon.

821. But other things being equal?—No, I should not expect to get the same results. Perhaps I had better give you an instance. There is a local tuberculosis known as scrofula. A guinea-pig is very susceptible to infection from human pulmonary tubercles, but if a guinea-pig is inoculated with scrofulous matter it will develop infection by a very slow process indeed. In this case I should say that I was dealing with tuberculous matter of a less virulent nature than if I had taken sputum or caseous matter from a case of general tuberculosis. That is an instance where a susceptible animal has been inoculated with tubercular matter derived from different sources.

822. That consideration would be of importance where it was a question of deciding between the safety and non-safety of using a particular piece of meat for food?—I have had no experience in that way, and therefore cannot say.

823. Matter from a caseated gland would not, I presume, be so rapid in its results, when introduced into an animal, as matter from disseminating tubercle?—I cannot say. I am not aware that any systematic observations have been made in connexion with any experiments of that kind. At the same time I am prepared to admit that such experiments ought to be made.

824. You would not like to infer that the development of tuberculosis in the one case would be more rapid than in the other?—No, I would not.

825. You have told us something about the difference in potency of *tubercle-bacilli* from different sources. Is the difference due to anything inherent in the bacilli themselves?—Yes, I should say so. We know perfectly well that different artificial cultivations of bacilli have different virulence. Some are extremely virulent, while others are much less virulent. In one case it would require only a few bacilli to be introduced in order to set up a regular tuberculous condition that would lead to general and fatal tuberculosis. In another case it would be necessary, before producing the same result, to stuff the animal, as it were, with bacilli.

826. What is the result of your experiments in passing *tubercle-bacilli* directly from the body of one animal to another?—In that instance, also, I think that in different cases a considerable difference in the virulence of the infection would be produced.

827. You have noticed a difference between the action of bovine tubercle and of human tubercle in the case of fowls and animals?—Yes.

828. The animals experimented upon were rabbits and guinea-pigs?—Yes.

829. The infection from the bovine tubercle was, I understand, more virulent than that from human tubercle?—Yes.

830. Can you, by passing it through the system of different animals, alter the potency of the *tubercle-bacillus*?—I know only of cases where tuberculosis has been produced in fowls—I mean where it has been produced with certain well-defined results. Different fowls, although inoculated with the same matter, did not in every instance show the same intense results. Then, again, if fowls were inoculated with matter obtained from guinea-pigs which had themselves received the infection from bovine tubercle, the development was much slower. Therefore, I conclude that the tubercle, when it passed into the fowl, had decreased in virulence.

831. Your experiments can be regarded as very valuable, so far as animals are concerned. Of course it is impossible to make the same experiments upon man?—Of course.

832. Are you aware of any difference of potency among *tubercle-bacilli* of man corresponding to the differences which you have observed among various *tubercle-bacilli* derived from cows?—I should say that in the first place the method of introduction plays a very important part. In the next place I should say that bacilli themselves, derived from different sources, or perhaps owing to other conditions, would produce different results. For instance, let me take the case of scrofula. There are cases in which tuberculosis is present in the tonsils and cervical lymph-glands which remain localised. It is, I may say, a common case, and therefore I should say that the method or means of entrance of *tubercle-bacilli* have something to do with the intensity of the result and the way in which the disease does or does not spread. I should say, also, that the actual introduction of the bacilli in one way or another plays an important part. But I do not think we have sufficient data to enable me to say with the same distinctness that that is the case in man as well as in animals, still I am led to think that there is a similar condition of things in man.

833. That the susceptibility to contract the infection is the same in man as in animals?—Yes.

834. Comparing tubercle introduced by way of the lungs and by means of the food eaten, what difference would there be in its potency in man?—In man?

835. Yes.—That is a point which has not yet been rendered satisfactorily clear. Sometimes tuberculosis appears in the alimentary canal in man with great intensity. Generally the lung is the most favourable organ for the growth of the *tubercle-bacillus*, but suppose it has entered through the alimentary canal, or further upwards through the tonsils, each might lead to the development of pulmonary tuberculosis. No doubt the lung is the most favourable organ for the development of tuberculosis, and therefore pulmonary tuberculosis is the most common form of the disease, but it does not imply that in all cases the *tubercle-bacilli* have entered by means of the lung.

836. Then you cannot speak with confidence upon the point that I put to you?—No.

837. I mean as to the way in which tuberculous phthisis has been produced?—I quite understand.

838. And would you say the same thing in regard to the mesenteric diseases in children?—Yes; although there are well known cases where the process has been established in the walls of the alimentary canal which have led further on to the infection of the mesenteric glands and other organs. In these cases I should say that the tubercular virus has entered the system by ingestion or feeding. If I did not find the alimentary canal tuberculous I should not be prepared to say that the infection was not produced by ingestion.

839. If you were to find in the mesenteric glands advanced deposits of the *tubercle-bacillus*, and no appearance of it in the mucous membrane of the

intestines, what would you infer from that?—I should infer nothing.

840. In regard to the cases of tubercular phthisis which we see in adolescence, should you regard it as being in a majority of cases, inherited from the parents?—There is certainly very strong evidence to show that that is the case; I refer to cases in which tuberculosis has manifested itself in a young child, or in a child of seven, eight, or nine years of age, or even after 20. There certainly is a good deal of evidence to show that in all those cases the tuberculosis may have been inherited. I do not say that it is inherited, but in a good many cases there has been evidence to show that it may have been inherited. But inherited tuberculosis divides itself into two things—first of all there is what is called congenital tuberculosis, which appears in the fœtus or in the young child. The records of such cases are much more numerous than they were some years ago when the prevalent theory was that there was no such thing as inherited tuberculosis, but that it was all due to an acquired predisposition or an acquired weakness of constitution. Since attention was called to the matter the cases have been more closely watched and more numerously recorded. Then, again, in regard to cases of latent tuberculosis, persons who have made a large number of post-mortem examinations state that they have found numerous instances in which there were distinct indications of the presence of tubercles, although they were very minute and slight. This has been the case in young children and in young persons up to the age of 20 or 30, and even more. Tubercles have been found in the bronchial glands or in the mesenteric glands. The deposits may even have become calcified, and there were no extensive signs of their existence, but there is no doubt that in a number of cases latent tuberculosis was present. I am not speaking of children but of young people and of persons up to 30 years of age, and the instances which are recorded are much more numerous than was formerly believed.

841. But nevertheless, in every case, you are of opinion that the infection dated from infancy or from before birth?—Yes. There is one consideration which always seems to me to be lost sight of in discussing the question of hereditary tuberculosis. We are told that hereditary taint means merely hereditary predisposition—a certain weakness inherited. That dates from the time when tuberculosis was not understood to be an infectious disease. It was merely thought to be a constitutional ailment, and not necessarily a disease of an infectious character. Since we have understood tuberculosis to be an infectious disease this hereditary taint as a predisposition has become quite meaningless. By an inherited disease we generally mean a disease the germs of which have been transmitted from father or mother—from the mother through the placenta on to the fœtus or earlier on to the ovum and from the father through the sperm on to the ova only. In connexion with tuberculosis the assertion that there is a hereditary taint is said to mean nothing of the sort; it is said to merely mean an inherited weakness of the tissues. That is putting tuberculosis upon an entirely different footing, and not said of any other infectious disease. We never dream of saying that the offspring had inherited a predisposition to contract a particular form of disease. It has been demonstrated that the tubercle-bacilli may be present on the mucous membrane of the Fallopian tubes of phthisical mothers. In a similar way there are well-established observations as to *tubercle-bacilli* having been found in the testes, from which tuberculosis might have been directly inherited. I should like to draw attention to the case of certain observations on fowls which are given at page 757 of Baumgarten's book. He gives a striking instance of inherited tuberculosis in fowls, from which I should like to translate a passage. He says that in 1883 Lichtenstein communicated observations which showed that on a poultry farm into which a cock had been introduced, the cock, which at the time of its introduction was in a perfect condition, developed in the course of a year a disease which, when the animal was killed, proved to be general tuberculosis of the abdominal viscera. The whole brood—all the chickens derived from this particular cock—were found afterwards to have developed tuberculosis. Yet there was no evidence whatever—no evidence that was not decided to be negative evidence—that the fowls could have obtained the tuberculous matter on this farm either from the bovine or the human species. And another cock on another farm was likewise found to be tuberculous; and on making further inspection it was found that the whole of the stock derived from this cock were similarly infected. These cases had been carefully investigated, and it was quite clear that they were dealing with tuberculosis inherited from the male bird.

842. You said, at the beginning of your evidence, that the supposed tendency of fowls to contract this particular form of tuberculosis had been exaggerated. Are you speaking now of tuberculosis similar to that which we have had under consideration?—No. I am speaking of the symptoms of tuberculosis which we find in fowls but not in the human or in the bovine species. The pathological symptoms of tuberculosis are the same, but in cultivation the bacilli are not identical with the bacilli obtained from the human and the bovine species.

843. (*Dr. Buchanan.*) The *tubercle-bacilli*, in the case you have mentioned, were found in the egg?—Yes, and so it is also in the case of hereditary syphilis in children. What the germ of syphilis is we do not know, but we know that it must have entered the ovum and remained there latent till after birth.

844. It is such observations as that which lead you to think that the *tubercle-bacilli*, and not merely a predisponent condition, have been transmitted from the parent to the child?—Yes; but there are many other observations in addition to that. For instance, there have been found a considerable number of animals—young animals—affected with tuberculosis which could not have got the infection in any other way than from having had latent inherited tuberculosis. In human beings there are well-known cases of tuberculosis which have been derived from one or other of the parents. In cases of hereditary taint, we are not dealing with a predisposition only, but we are dealing really with cases where the germ of the disease has been inherited; in such cases the germ must have been transmitted from one or other of the parents to the child; probably from the woman through the ovum, or through the placenta, or from the father through the sperm.

845. You do not find any difficulty in arriving at that conclusion?—No.

846. (*Chairman.*) If it be so, and a large proportion of consumption in mankind is due to hereditary transmission, would not that, so far, very much reduce the importance of the question we have before us, which is, how far consumption is due to infection from animals, and what is the effect, if any, of food derived from tuberculous animals on human health?—I can only repeat what I said just now in regard to hereditary taint. So far as the evidence goes I should certainly be prepared to say that a large proportion of human tuberculosis is inherited.

847. (*Dr. Buchanan.*) Can you tell us whether there is any pathological test by which we can be sure of the way of entrance of the tubercle; and if you cannot tell us that, can you tell us the result of your own observation as to the differing extent of tuberculosis introduced by heredity, by feeding, by the air, and in other ways?—I am not quite clear about the evidence with regard to the per-centage of tuberculosis in human beings which is not derived from tuberculous parents; that is the first thing I should like to be clear about. We do not know exactly what is the per-centage of people by whom it is not derived by heredity.

848. (*Chairman.*) You say that a considerable proportion of tuberculosis in human beings is

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inherited, but other gentlemen whom we have examined have expressed a different opinion, and say that it is not so, but that all tuberculosis is derived from infection in the same way that typhoid fever is derived. Do I understand you rightly?—What I want to convey is that if we had tables showing what is the percentage of people who have contracted tuberculosis without having derived it from tuberculous parents, I should then be able to form a better judgment. That is what I meant, but, unfortunately, we have no definite statistics on the subject.

849. (*Dr. Payne.*) I think there are statistics?—But are they reliable?

850. There are statistics, but they differ very much?—I am not quite clear about the matter myself. I do not know how far the statistics really do prove anything. We know that there are cases. I, myself, when I have investigated instances of acute tuberculosis in children, have paid attention to that point, and I found that in many cases there was no history save that of the parents themselves. Baumgarten, who has had a large experience, says that it is not necessary the immediate parents should have had tuberculosis, but that the grandparents may have had it; it might have been altogether latent in the immediate parents, and yet tuberculosis might have been produced in the offspring. That is an explanation to a certain extent. I am not quite clear how far there are statistics which prove what the percentage is of people who have been infected with tuberculosis who have derived it from people who were not subject to the disease.

851. (*Dr. Buchanan.*) Do you think you would be able to deduce any conclusion or inference from the examination of calves?—Yes, I think that might be possible if the observations were extended over a period of several years.

852. At the same time it would only be an inference?—Yes, that is so. When I hear of statements that 25, or 30, or 40, or 50 per cent. of cattle are tuberculous and must have acquired the infection as adult cattle, I am not clear that such statements are made upon evidence upon which I can rely as trustworthy. I do not know, in the first place, what is the percentage of calves which have inherited tuberculosis. If I knew that and could compare the returns for a long series of years, I should be able to say whether any great number of cattle which have tuberculosis have inherited it or not; I should then be able to draw an inference how large a number of adult cattle have acquired and not inherited it. But to give an opinion now would, I think, be going beyond the evidence. I am unable to say that; the available evidence is not sufficient.

853. Some information as to heredity would be got in regard to human beings if we could learn what the number was who were born of tuberculous parents and what the number was who were born of healthy parents, among the total sufferers under tuberculous disease?—Yes.

854. Could any valuable information be derived from the experience of Life Insurance Companies which, as a rule, decline to insure persons whose parents have been infected by tuberculosis?—Yes, I should think so.

855. Information of that kind would be of use?—Yes.

856. Are there not records of this sort kept in the hospitals for the treatment of consumptive patients?—Yes.

857. Such records have been kept and may be obtained?—Yes.

857*a*. (*Dr. Payne.*) No doubt records have been kept, but it is a remarkable fact that they differ very widely?—I believe that is so.

858. I cannot enter into particulars, but I may take two cases in which the returns show in the one case that the tendency in consumptive patients is to have acquired it by heredity, while those in the other tend to show that there is no history of the disease having been inherited.

859. (*Chairman.*) We have had before us one witness who denied that there was any history of heredity at all. He disputes the hereditary nature of tuberculosis altogether. If we could assume that a percentage of the disease is hereditary we should know what we are about. What we want to know now is, what influence the eating of tuberculous flesh and the drinking of tuberculous milk have in spreading the disease?—I should say that the consumption of tuberculous flesh and milk wholesale without inspection and restraint should not be permitted. I have no desire to minimise the danger, but I believe that the amount of tuberculosis existing in the flesh and milk provided for consumption can be ascertained, and the supply of infected articles restricted. This could be done by employing competent authorities to perform the duties of inspection, but this would not be altogether efficacious, and tuberculosis, I am afraid, would still prevail. The authority I quoted a short time ago tells us that in Germany the milk is always boiled and the meat carefully inspected; nevertheless, there is a large amount of tuberculosis about, and the gentleman to whom I refer concludes that most of that tuberculosis is hereditary.

860. (*Dr. Buchanan.*) We should be glad to have more information upon that subject if you are able to give it to us. What has been discovered as the outcome of the precautions that have been taken in regard to milk and meat in different parts of Germany?—I do not know that there has been any.

861. Probably there has not been time?—No, I think not. Baumgarten is one of the highest authorities, and he says that where the milk is boiled the risk of infection cannot be very great, and that where the cattle are carefully inspected the risk cannot be very great. He further shows that tuberculosis from inhalation has not been proved to play a very large part in the spread of disease, although Baumgarten admits that tuberculosis has occurred in the alimentary canal from swallowing sputa. The conclusion he has arrived at is that in all probability the largest percentage of tuberculosis among human beings in Germany is by inheriting it.

862. (*Chairman*). Do you know that restrictive measures have been taken in Copenhagen for some years. I mean restrictive measures in connexion with the supply of meat?—Yes, I have heard that that is so.

863. Say that they have been going on for three years. In three years would you expect to find the effect of the regulations made manifest?—Yes, but I do not know.

864. Would you expect to find that an improvement in the public health would have followed after three years?—Well, three years would be rather a short time when you are dealing with a chronic disease.

865. (*Dr. Buchanan.*) You have not heard that any improvement either among children or adults has followed upon the measures which have been adopted in Germany?—No; I am not acquainted with the statistical records, and I should not like to express an opinion either one way or the other.

866. (*Prof. B. Sanderson.*) I have not very much to ask you, Dr. Klein, but there are a few questions which I should like to put. You have spoken of a predisposition to tuberculous disease, and you have referred to two kinds of predisposition which I may call non-specific and specific?—In what way non-specific?

857. I mean transmitted by means of transmitted weakness?—Yes, hereditary weakness.

868. And on the other hand a specific tendency to tuberculosis?—Yes.

869. Do you believe that there is such a thing as transmitted weakness which is not specific? Have I sufficiently made my meaning clear?—Yes, I think I understand you, but I am considering what reply I ought to make. Of course the weakness would mean a less resistance of the tissues to particular attacks.

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870. Yes, that is what I mean also?—I can imagine such a thing. I do not see how I can deny it. Speaking of fowls, we know, for instance, in the experimental results which have been obtained, that in introducing a pathological state into the ova which shall not interfere with the development of the embryo, that the embryo when it appears is less capable of resisting disease. I am speaking of pneumonia organisms which have been introduced into the ova. If the injury has not been extensive, so that the hatching has not been interfered with, the chicken after it was born would show a greater predisposition to pneumonia than an animal which had not been subjected to the same treatment.

870*a*. But not a specific predisposition to pneumonia? —No, but I can imagine that. I can imagine that a plant or animal derived from a weakly plant or animal would not be so hardy or so strong as another plant or animal.

871. And in the case you mention the fowl subjected to the treatment you have described would be more liable to tuberculosis?—Yes, or to another disease.

872. We have been told that a predisposition may be acquired by an animal at a later period of life through some other disease; what is your opinion upon that point?—A predisposition to tuberculosis?

873. Yes. I do not know that I can say that; but I do know that a pregnant woman will develop a slower process of tuberculosis, and that it can be arrested; but I do not know of a recorded case where, through a different disease, the predisposition to tuberculosis has been increased. I am aware that statements have been made that people with a certain weakness of lung tissue are more liable than others. That may be the case, but I know that there are a large number of persons with diseased lungs and in weak health who do not contract tuberculosis, although they are exposed to infection.

874. In short, you do not know that there is any reason for thinking that weakly persons, free from tubercle, are more likely to acquire it by infection from other people?—I can only judge from analogy. I have no definite data to go upon. I know that persons in a weakly state of health are more liable to infection with some diseases than persons who have a stronger and more robust constitution. How far that extends to tuberculosis I do not know, seeing that there are no data to go by. It is perfectly possible that a certain weakness of tissue or a lower vitality—either condition may influence to a greater or less degree a predisposition. I may mention that experimental results of an interesting character have been obtained in Professor Koch's laboratory in regard to phlorizen—a substance which, when administered to certain animals, had a predisposing influence over them. Phlorizen produces a sugar deposit in the tissues. In the case of glanders, for instance, it rendered animals, ordinarily not liable, more susceptible to the disease. That is not a remark, however, which applies to tuberculosis. Guinea-pigs and domesticated animals have been treated with this substance so that their tissues contained a considerable amount of sugar, but it has not increased the susceptibility on the part of the guinea-pig towards contracting tuberculosis. What may apply to one disease may not apply to another disease, and what may apply to one animal may not apply to another animal.

875. (*Prof. Brown.*) I understood you to say that there is distinct danger to a human being from eating tuberculous flesh and drinking tuberculous milk?—I cannot deny that there is a risk. We know that animals which have been fed upon food containing *tubercle-bacilli* have developed tuberculosis, and therefore to drink milk or eat flesh containing the *tubercle-bacillus* will represent a certain amount of risk.

876. Then would you say, on that assumption, that it is desirable for the Commission to obtain evidence that animals which are infected with tuberculosis can infect mankind with human tuberculosis; and, therefore, if we can show from the evidence that meat and milk from tuberculous animals will produce disease in other animals, it may be concluded that the same danger and risk is incurred by the human species?—I would certainly say yes.

877. We want your opinion upon that point because we cannot ascertain from actual experiments on human beings whether the drinking of tuberculous milk or the eating of tuberculous meat is dangerous or not. Supposing that they are likely to produce it, would it not largely increase the risk of transmission by heredity?—I should certainly say yes. The people who eat tuberculous meat or drink tuberculous milk may contract tuberculosis themselves.

878. Therefore it becomes very important to prevent the consumption of these dangerous articles as food?—Certainly.

879. Is there any suggestion you have to offer as to the practicability of an inspection of meat and milk so as to prevent the introduction of tuberculous food to the people?—I think it is a very difficult matter to regulate by inspection in any practical way. For instance, it is possible to examine milk and meat and yet not find tubercles, although more complete and scientific experiments would make their presence manifest. There are experiments recorded in which the existence of tuberculosis in the flesh has not been demonstrated, and yet tuberculosis has been produced by inoculation with such flesh. The difficulty is that the process is one which requires a long time to develope the results. It would be impossible, for instance, to say in six or eight weeks whether the animal had tuberculosis or not.

880. And it would be necessary to decide at once whether the meat should go into consumption or not? —Certainly.

881. Is there anything you can suggest as a reasonable test?—I am not aware that there is.

882. Is there anything you can suggest that ought not to be done?—Yes.

883. What is it?—I think it would be very difficult to lay down a rule in the negative, and to say, from microscopic examination, "In this material there "are no *tubercle-bacilli*." It would be extremely risky to say that there are no *tubercle-bacilli* in a particular sample of milk, because we cannot demonstrate them by microscope, since it has been shown to be possible by inoculating a susceptible animal with that milk to produce tuberculosis. What I would suggest that should not be done is this: I have seen butchers when dressing meat use a knife to cut through the glands and other organs, and then I have seen them use the same knife to trim the meat with. By that means I think there is a danger of infecting meat which had not previously been infected.

884. You are of opinion that a butcher, in the act of trimming off the pleura or the peritoneum, may infect the meat generally which would otherwise not be infected?—Yes, I should say so.

885. How would you suggest that he should proceed with an animal which has a tuberculous deposit in the peritoneum?—I saw in a journal the other day a good suggestion made in regard to Berlin and other parts of Germany, namely, that the inspector first of all, when a carcase is opened and it is seen before the cutting up is done that there is tuberculosis in the lungs, should first remove those parts of the meat which are at a distance from the lungs, in order to find out whether any tuberculous deposit exists in them. If no tubercles are found in them, they are retained, but if tubercles are in them, the whole animal would be condemned, but in any case the organs which conspicuously contain tubercles should at once be destroyed. I think that that would be a good rough-and-ready way of treating the meat in such circumstances.

886. You are aware that in many cases there are deposits which are described as "grapes," although there may be no deposits in the lungs?—Yes.

887. The butcher clears all this off with his knife? —Yes.

888. Is there any suggestion you are able to make that would enable this to be done without running any risk of conveying some portion of the deposits to the flesh that is intended for food?—I do not see how it is possible to avoid all risk.

889. Then it really comes to this, that the butcher in trimming the meat, and attempting to disguise the fact that the animal had tuberculosis, really renders the tuberculous deposits more dangerous than if he left them alone?—I should certainly say that that is so. I may also add, that if I found an animal that had no conspicuous general tuberculosis—in cattle, for instance—and if I did not find any distant lymph glands with suspicious nodules or deposits, I should still regard it as a case of possible existence of general disease.

890. The meat would then have to be cut up into joints before the existence of disease could be detected, and a whole carcase condemned?—I am afraid that that would be necessary.

891. Are you not aware that the adoption of a system of that kind would upset the whole of the meat trade in this country. At present the meat is inspected in the slaughter-house, and the whole carcase is divided down the centre, and sent to the Meat Market. It is not cut up until it gets into the hands of the retail butchers?—I am afraid that I cannot offer any advice in the matter.

892. But you are aware that it is so?—Yes, I believe so.

893. I am anxious, if possible, to get out these points, because the matter, as far as I am concerned, will have to assume a very practical shape?—I am quite aware of that.

894. (*Dr. Payne.*) I wish to ask you, Dr. Klein, whether you have any actual evidence that calves have acquired this tuberculous disease from mankind?—No, I have not.

895. (*Prof. Brown.*) I thought you had performed experiments in that direction?—No, I have not.

896. (*Dr. Payne.*) Do you think that the morbid anatomy of a man or a child dying of tubercle can give any distinct evidence whether the tubercle was acquired through the digestive or the respiratory organs?—In certain cases there has been evidence that tuberculosis had been acquired through the digestive organs; in some cases tubercular deposits are found in the walls of the alimentary canal. And from here they can be traced further into the mesenteric glands. But in reference to pulmonary tuberculosis, I do not think there is any evidence to show that it had been acquired directly by the lung by inhalation.

897. Do you think it is acquired from a tendency towards the development of tuberculosis in the lungs?—Yes, that probably is the case. The lung is a very favourable organ for tubercle.

898. Do you think that *tubercle-bacilli* are widely diffused everywhere in London?—Yes, I should say so.

899. Have you ever found them in dust, or in water, or in the air in any way?—No, but I must confess that I have not looked for them.

900. In your laboratory have you ever found that *tubercle-bacilli* come up constantly?—The *tubercle-bacillus* is an unfortunate organism in this respect, because it cannot grow in any media, and particularly when at the same time other organisms or microbes are present in such media. In such cases the *tubercle-bacilli* are soon killed by these other organisms. Besides, the *tubercle-bacilli* take a long time to start in artificial media, and it is very selective as regards the nutritive media.

901. At all events you have never had any evidence that *tubercle-bacilli* do exist in the external universe?—I will not go further than this. They grow in the Brompton Hospital. *Tubercle-bacilli* have been found in the dust of the rooms. I was told that fact only the other day.

902. You have not yourself made any particular observation in that respect?—No, but I know that the sputum of phthisical patients contains spores, and when one has been in a large room crowded with people, or sat in a railway carriage or in any confined space full of people, one sees a large amount of matter expectorated, which must contain tubercles and a good many of their spores.

903. Are there any means of detecting these spores?—None that I am aware of.

904. They are not coloured?—No, I do not say that the spores are coloured or not. I say that there is no evidence of the fact either way.

905. As to the question of inheritance, you are, of course, aware that the insurance companies look upon persons who come from consumptive families with great suspicion?—Yes.

906. It may not have been the father or mother who suffered from tuberculosis, but the applicant may have had a brother or sister, an uncle, or an aunt, or, perhaps, a grandfather or grandmother who was a tuberculous subject, in that case can you say whether there would be a tendency to transmit the germs of the disease?—I do not quite catch the point of your question.

907. Would a person have an hereditary tendency towards consumption whose brother, or sister, or uncle, or aunt had had it?—Could not the germ be transmitted in that way, although the immediate parents manifested no signs of tuberculosis?—Yes, there may have been an uncle or aunt in whom it may have been developed, but in this case also the brother or sister of that uncle or aunt, *i.e.*, the father and mother of the person in question, may also have had latent tuberculosis. Inherited weakness in this category of cases stands on all fours with inherited germs of the disease. In many cases the existence of tuberculous nodules has been shown in one or other organ without the individual having shown any signs of tuberculosis during life.

908. But having nodules of tuberculosis, say in the glands, would the person possessing them be capable of transmitting tuberculosis to the offspring, although he or she never manifested any symptom of the disease?—Yes, I think so, unquestionably.

909. And although it came from the glands?—Yes, I do not say that I actually know it, but I do not deny the possibility of it.

910. Taking the case of the Zoological Gardens, it is clear that the animals there do not acquire these tubercles by inheritance?—No, they do not.

911. Then do you think that the places there are very probably infected?—Yes.

912. (*Chairman.*) Do you think that the monkey house is full of it?—Yes.

913. And therefore that human beings catch it?—Yes, they may catch it.

914. (*Dr. Payne.*) Is it an inherited disease in cattle?—I am not clear as to the number of calves which live and become adult cattle before showing signs of tuberculosis, but some calves undoubtedly have it from their birth. I do not deny the possibility of cattle contracting the disease in the stables or shed, and so on, but before I form a definite opinion, I want to know the percentage of calves that contract tuberculosis, and do not inherit it.

The witness withdrew.

Adjourned until Wednesday, November 12th, at 2.30 p.m.

EIGHTH MEETING.

7, Whitehall Place, S.W., Wednesday, November 12th, 1890.

PRESENT:

THE RIGHT HON. THE LORD BASING presiding.

Professor G. T. BROWN, C.B.
Dr. G. BUCHANAN, F.R.S.
Dr. J. F. PAYNE.

Mr. LEOPOLD HUDSON, *Secretary.*

Dr. J. EDWARD SQUIRE, M.D., London, M.R.C.P., Physician to the North London Hospital for Consumption, called in and examined.

Dr. J. E. Squire, M.D. Lond., M.R.C.P.

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915. *(Chairman.)* Will you tell the Commission, Dr. Squire, what the position is which you occupy? —You desire to know my medical qualifications and the position which I occupy in the hospital?

916. Yes?—I am a Doctor of Medicine of the University of London, a Member of the Royal College of Physicians, and one of the physicians of the North London Hospital for Consumption.

917. For how long have you filled the latter capacity?—For about seven years, or nearly eight. I have been one of the physicians for in-patients for the last three years, and previously, for about five years, I had charge of the out-patients.

818. Is the hospital generally full, so far as patients are concerned?—Yes.

919. How many beds are there?—One physician has about 20 beds under his charge. There are three physicians, there will be altogether about 60 beds.

920. Are you the sole or chief authority of the hospital?—No; I only take my share. The responsibility is divided among the three physicians.

921. I am only trying to ascertain the extent of your experience in connexion with the hospital. You say that you have 20 beds under your charge?—Yes.

922. What will be the average number of patients you are called upon to deal with?—Perhaps I had better put it is this way. I had, first of all, five years seeing out-patients, with an average attendance of about 60 patients a week, and then three years with charge of in-patients.

923. What you have said is quite sufficient. What I wanted was to get an idea of the extent of your survey during the last seven years and more, in regard to cases of this character which have come under your immediate observation, an observation which has been very large indeed?—Yet, it has been large.

924. You began your work, I believe, long before the period of the discovery of the *tubercle-bacillus?* —No; it was in 1882 when the *tubercle-bacillus* was discovered, and I did not begin my work at the hospital until just after that date.

925. You are of course acquainted with all the literature and the investigations which have been made in connexion with tuberculosis and *tubercle-bacilli?*—Yes.

926. May I ask you if your experience confirms the theory that tuberculosis is a disease communicable from man to man in the same way as typhoid by means of a germ?—Yes. My experience confirms, first of all, the statement that the bacillus is the necessary factor in the causation of the disease, and that the disease may be communicable from person to person, from person to animal, and from animal to animal. It is apparently communicable also from animal to man. I do not say that from my own experience, as I only speak with authority as to the communication of the disease from person to person; but from the knowledge I have acquired of the subject, I should also say that it is capable of being communicated from animal to man. The literature upon the subject affords, I think, sufficient evidence that it is communicable from animal to animal and from animal to man.

927. Do you go as far as to say that since the discovery of the peculiar character of tuberculosis there can be no cause for what we call consumption except through the agency of an infection of this sort?—You mean tubercular consumption?

928. Yes?—Then I should certainly say so. I should say that there can be no case, except from infection by the *tubercle-bacillus.*

929. That is to say, that a human being catches tuberculosis as he would catch typhoid fever?—Yes, I should say that the cause of the infection is something of that kind, but that the mode of infection is different. It is the same only in this respect. In both cases you have an infective particle that must find entrance into the system before disease can result; but the difference between the two is in the mode in which the infection gains access into the body. What I mean is, that the mode of access in the infection of typhoid fever is not the same mode of access as in the infection of tuberculosis. The two are similar to the extent that both are due to the fact that an infective particle must find access into a healthy body before the body itself becomes diseased. To that extent there is a similarity between the two.

930. Will you kindly explain what you mean when you say that the mode of infection is different, because we know that typhoid fever may be contracted by eating, drinking, or by inhalation. What other modes are there by which consumption can be contracted?—We are getting a little away from tuberculosis, I think. I should say that in the case of typhoid fever the germ would hardly go from one person to another direct from eating and drinking. As a general rule, the germ would be passed through by evacuations. It is necessary that it should undergo some development before it gets into the water, or the milk, or whatever it may be, and is then developed in another person.

931. Still, the way by which it gets into the person infected must be similar in the case of tuberculosis to the process of infection in typhoid fever?—Yes, it is similar.

932. It is, I suppose, either by inhalation or by ingestion—eating and drinking?—Yes.

933. You lay down as an absolute proposition that tuberculosis or consumption is the same disease in animals as in man?—Yes.

934. And that it is communicated in the same way, by infection?—Yes.

935. What do you say in regard to an hereditary predisposition to contract the disease?—Hereditary predisposition depends chiefly on inherited weakness of the general constitution, which allows the infective particle — the *tubercle-bacillus* — which has gained entrance into the body to find suitable food for it to develop, and a suitable condition of the tissues to permit of its settling down and growing. But inherited

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predisposition does not go further than that. It certainly makes a person, in consequence of some general lowness of health, more liable to succumb to an attack of infection and to develop the infection, but an inherited predisposition would not alone give tubercle to any person.

936. You lay that down as a general maxim and proposition?—Yes, that is certainly my own opinion.

937. Then however weakly a child or young person may be he would never get the infection if he did not get it in this way?—That is my opinion. There is just one possible exception, namely, that it may have been found existing in the fœtus before birth. It has been found that even the fœtus of an animal as well as of a human being has been infected before birth with *tubercle-bacillus.* But in that case you do not get inherited predisposition; you get the inherited disease itself.

938. The infection existing already in the body?—Yes, but a predisposition to contract the disease will not give the disease itself without the admission of the infective particle into the body.

939. You are aware that the managers of life insurance companies are very reluctant to accept proposals from persons whose relations or ancestors have died of consumption?—Yes.

940. Although they may have some reason for taking that course, you do not regard it as a necessary consequence that, apart from absolute infection, they would contract the disease of tuberculosis?—No, I do not look upon it as a thing that would necessarily befall them in the absence of infection; but I think that the course taken by the insurance companies is perfectly correct, for this reason, that such persons being the children of unhealthy parents would be likely to be persons of a lower vitality than others who came of a healthier stock, and would therefore be more liable to contract tuberculosis; the more so, from the very fact that they were living among persons who were already infected by the *tubercle-bacillus.*

941. The reluctance I speak of on the part of life insurance companies to accept proposals from persons of this character, relates not only to the parents but to collateral relations, such as brothers and sisters, uncles and aunts, the parents themselves being apparently healthy?—In that case I think the weakness alone is inherited, and if these persons were placed under favourable conditions, I do not see the slightest reason why they should become tubercular.

942. I understand you to say that tuberculosis is pre-eminently communicable?—Yes.

943. Communicable from man to man?—Yes.

944. And apparently from animal to man?—Yes.

945. The reason why I wish you to give to the Commission a statistical account of your experience, which must be very large, is that I may base upon it this question: In your lengthened experience, having had hundreds of cases brought under your notice, have you ever heard or known of cases in which tuberculosis was probably contracted from the eating of meat, or the drinking of milk, from an animal more or less infected by the same disease?—I am afraid that I am unable to mention any definite case in which it was possible to say at once that that was the cause. The chief reason being that in London especially, and in all large towns, people may be subjected to the possibility of contracting infection from eating meat or drinking milk; but at the same time they would also be liable to infection from inhalation, and it would be difficult to put either cause aside, and say that it could not possibly have operated in producing the infection.

946. It is our duty to ascertain what risk, if any, there is in the eating of meat or drinking of milk from a tuberculous animal. So far as your experience goes, no instance has been brought under your notice which enables you to say that there has been a case so decided as apparently to affect the wholesomeness of the meat offered to the people for consumption?—Just so, but in the answer I gave I was alluding more particularly to the effect upon children. In them, as a rule, one finds the first signs of tuberculosis in the intestines, or in the glands of the abdomen, I mean the first glands that are passed by the fluids from the stomach going up to the blood stream.

947. What we call mesenteric disease?—Yes, one form of it; it is more frequently the case in children than in grown up people. In the first years of life children are almost exclusively nourished on milk, and where the mother is tuberculous herself, and nurses her own child, there is a risk in such cases of infection from the mother's milk. It is well known that, as a matter of fact, we generally ask a mother who is suffering from tuberculosis not to nurse her own child, on account of this risk. Then again, in regard to children who are hand fed, this mesenteric disease is very common, and one supposes that it is due to the milk they take, although they do not get it from the mother. The reasons for drawing these conclusions are, first of all, that the result of examination has shown that *tubercle-bacilli* were present in the milk of the mother; secondly, that the infection of that milk in animals would produce tuberculosis; and, thirdly, that animals fed on such milk have become tuberculous, first of all, in the intestines, and then in the mesenteric glands. Later on, the infection has become generalised. That is the account which has been given of the effect of feeding upon milk so infected. The tubercle is formed in the intestines and the mesenteric glands, and then general tuberculosis sets in. But in the case of persons who contract the disease from being exposed to infection by the air, it will be found that the lungs are the first organs attacked, and not the intestines and mesenteric glands. If these become infected at all, the infection manifests itself at a much later stage, and the supposition is, that when it does manifest itself later on, it may be due to the swallowing of infective matter (sputa) which in that way infects the intestines as a new infection altogether. In other words, those who have paid attention to the subject think that the point of the infection may be determined by the seat of the first tubercular deposit. If it is in the intestines and the mesenteric glands, the presumption is that it reached the system through the intestinal canal.

948. I believe it is the fact, that an immense number of children are subject to mesenteric disease?—Yes, and in a large number this is tubercular.

949. And you think that a certain proportion contract it from the mother?—Yes; a large proportion, in my opinion, contract it from taking the mothers' milk.

950. But you say that if the mothers were healthy, they could not contract it from taking the mothers' milk?—No; if you had a mother who was not tuberculous, who had never been infected with the *tubercle-bacillus,* who had nourished her child, and whose child had never had any other food than the mother's milk, it is hardly conceivable that the child should get the mesenteric disease.

951. Very well; let us put aside the case of infection from the mother; are there not an immense number of children who die from this disease?—Yes.

952. Does the disease affect more the children of the poor than the children of the rich?—I think it affects more the children of the poor. I may, however, have drawn that conclusion from the fact that my experience has been gained principally from the children which come into the hospital.

953. You are referring to children who are not nourished as they ought to be. Is it not a matter of common complaint that the unhealthiness of young children and the risks they run are brought about by feeding on unnatural food and not on milk?—Feeding on unnatural food would not introduce tuberculosis into the intestines, but you would have a different kind of disease which may be called popularly consumption of the bowels. It is a popular expression, which signifies a wasting disease.

954. Nothing, I take it, shakes your conviction that tuberculosis, as a disease, is communicable in the way you have described?—No.

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955. And that all the consumption we know of is contracted in this way ?—That is my belief.

956. But still you cannot point to any cases, in connexion with which your suspicion has been aroused or which have enabled you to conjecture that, as a matter of fact, so-and-so contracted the disease from eating meat or drinking milk, as the case might be, which came from an animal infected with tuberculosis ?—I can call to mind cases where I have no hesitation in saying that the child contracted the disease through being fed by a tuberculous mother, that is to say, from the mother's milk, but I have known cases also where a child has been infected who has been fed upon cows' milk. I had no means of examining the cows from which the milk came or of testing the milk itself. At the same time, I have had strong suspicions that the animals from which it was drawn were tuberculous.

957. Will you take the case of the adults in the hospital with which you are connected, and of whom you have seen so many. Are the symptoms you have described those in certain cases of persons who were healthy and well-conditioned, but who suddenly broke down as it were from inhaling poison ?—Yes, I have seen many cases of that kind, and in the majority of them, the persons attacked have undoubtedly been persons who were living under certain conditions which tended to weaken the resisting power of certain organs. For instance, there are people who have been engaged in particular industrial occupations which have compelled them to inhale a large amount of dust. The lungs of such persons have become liable to a sort of chronic lowness of vitality, and they have been rendered more liable to be infected by a certain class of diseases. So also in the case of a nurse. Perhaps I may be allowed to give an example. It is a case which happened under my own observation. A short time ago, a nurse who came of a very healthy stock, and who had no previous taint of tuberculosis, was nursing in a hospital for consumption, when she contracted a bronchial complaint, the result of a slight cold; before she had completely recovered from her cough she was put to nurse a case which required special attention. Some three months afterwards, while still nursing in the hospital for consumption, she exhibited signs of infection by tuberculosis. The disease made rapid progress, and eventually proved fatal in about six or eight months. It all arose from an attack of bronchitis in the first instance, which rendered her lungs liable to receive the infection.

958. Do you know of any healthy people, or have you ever heard of any, who have become consumptive in consequence of partaking of beef or some other substance which has contained the germ of the disease ?—No, I do not think that a healthy person without a predisposition to contract the disease would become infected. A person in good health is not likely to be infected, either by germs in the air or contained in the milk he may drink, or the meat he may eat, because, I believe, the tissues themselves have power in such a case to protect an individual, or, at any rate, to dispose of the germs. It becomes a fight, as it were, between the healthy tissues and these germs.

959. That seems to be a very interesting statement of your opinion, but how far would you allow it to influence your action in permitting the use of flesh or milk of a doubtful character, as articles of food? I understood you to say that it is only a case of suspicion that people may contract tuberculosis in this way. You say that the majority of healthy people would not be so liable to contract the infection from meat or milk as from the air, that they would inhale it rather than contract it by eating tuberculous food. That being so, you reduce the importance or urgency of restrictive regulations as to the use of meat which may be exposed for sale to an appreciable point ?—What I mean to say is, that if proper care is taken of the health of the people, you might very well omit compulsory restrictions and leave healthy people to look after themselves. But it must not be forgotten that all people are not naturally healthy, that there are many who are depressed in health who may have inherited weak constitutions, which have a tendency to render them liable to contract disease. It seems to me, therefore, that their case must be taken into consideration as well as that of persons who are healthy and robust. While I believe that a healthy man might eat tuberculous meat, or drink tuberculous milk, without suffering from it in the least degree, I cannot ignore the fact that healthy men do not constitute, by any means, the whole of the population. In saying this, I wish to add that I am speaking without any absolute data to go upon. I have had no proof, so far, that the eating of tuberculous meat, or the drinking of tuberculous milk, has been absolutely dangerous. No such case has come under my observation in the hospital, and, therefore, I am not able to confirm my opinion by the actual result of experiments.

960. I understand you to lay down the theory that the danger from milk would be far greater than any risk from eating tuberculous flesh ?—Yes, I should certainly think so.

961. And, therefore, if anything is done to protect the public at large, the first thing to do would be to look after the milk ?—Yes; and then we come to another point. It appears that milk can, in a large number of instances, be rendered entirely or practically safe by boiling; yet, on the other hand, there have been instances in which the boiling of milk has not got rid of the *tubercle-bacillus*.

962. Are there any recorded instances to that effect ?—Yes. Dr. Klebs infected two animals with milk which had been previously boiled, having previously ascertained that the milk was tuberculous by infecting animals with it when in an unboiled state. The unboiled milk produced infection, and Dr. Klebs then, in two instances, injected milk which had been boiled. In both cases tuberculosis was produced. In Gerlach's experiment 15 animals were fed upon cooked tuberculous matter, and out of the 15, 10 became infected, so that, in a majority of cases, it would not appear that the cooking of meat capable of conveying infection would render it safe. Of course, in the cooking of meat, the internal part of the flesh never gets raised to a very high temperature; consequently, as I have said, it is possible for meat to remain infective even after it has been cooked.

963. You believe that it is possible, then, to contract infection by eating tuberculous meat ?—Yes, I believe that is so.

964. Is that an opinion which has arisen since the discovery of the *tubercle-bacillus* within the last 10 years ?—I cannot say that.

965. It has only become prevalent within the last 10 years; before then, I believe, the *tubercle-bacillus* was unknown. Is not that so ?—The possibility of infection by tubercle was believed in by a large number before it was proved to be due to a germ. But the discovery of the bacillus led one to draw an analogy between tuberculosis and such diseases as enteric fever and some other diseases of which these germs were found to be the cause, such as anthrax and relapsing fever. The analogy was drawn, and the conclusion arrived at was that it must be an infectious disease, and communicable, that is to say, that you must first get the germ before you can have the disease. It was certainly imagined that the disease was communicable long before the germ was thought of.

966. It was thought, I suspose, that one person might contract the disease by breathing the breath of another person ?—Yes.

967. In the way that other contagious diseases are supposed to be contracted and spread ?—Yes, that is the general opinion.

968. But now the thing is much more specific, and is better understood ?—Yes, I think there is a general understanding on the point. Gerlach, in 1870, produced tubercles in an animal by feeding it with milk

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from tuberculous cows. He published his observations in October 1870, so that was certainly 10 years before the *tubercle-bacillus* was found at all, I believe it is the fact that experiments were made with tuberculous milk before it was discovered that the infection might be due to the entrance into the system of germs. Of course the milk used in carrying out the experiments was known to be infected with tuberculous matter. It will therefore be seen that the question was not one only of the inhalation of the *tubercle-bacilli*, but that experiments were made in the direction of infecting animals by feeding them upon tuberculous food.

969. Then we do not know whether the stringent regulations now enforced in Denmark and in parts of Germany in regard to the sale of meat and milk have brought about a diminution of disease, even in the event of the state of the public health having shown an improvement? — I have no means that would enable me to say that.

970. But you would certainly expect, would you not, that if the eating of tuberculous meat and the drinking of tuberculous milk constituted a widespread source of consumption among human beings, that a few years of stringent regulations would show a perceptible improvement in the health of the people? —I should expect the improvement to be shown rather in an improvement in the health of the younger people. So far as I am able to form an opinion on the subject, I should say that the risk of infection from the eating of tuberculous meat and the drinking of tuberculous milk is far less than the risk of infection from the *tubercle-bacilli* in the air; so that if you were entirely to prohibit and cut off the use of tuberculous food, still a very large proportion of the persons who now have phthisis would still contract consumption by what they inhale from the air.

971. (*Dr. Buchanan.*) You spoke of the observations made by Dr. Klebs as well as those of Dr. Gerlach?—Yes.

972. I believe they also date from about the same period as those of Dr. Gerlach?—Yes; they were about two or three years later. Those of Dr. Klebs were made in 1870, and those of Dr. Gerlach in 1873 or 1874.

973. Klebs had not at that time made any observations in connexion with the *tubercle-bacillus*, or expressed any view as to the vitality of micro-organisms before and after boiling?—No, certainly not; and for this reason, that this particular form of micro-organism had not yet been fully discovered.

974. I believe you are able to give us some facts in relation to animals kept under artificial conditions in the Zoological Gardens and elsewhere as contrasted with wild animals. Will you tell us what your experience has been?—In offering an opinion, I shall of course have to rely, not only upon my own experience, but upon the experience of others. Dr. Crisp, in the Pathological Society's transactions, says that he found tuberculosis in over 100 specimens of vertebrate animals, including mammalia, birds, and reptiles, but that he never found it in animals in a wild state, though sometimes in wild animals kept in the Zoological Gardens. I believe it is an undoubted fact that tuberculosis has never been found in wild animals.

975. (*Chairman.*) You do not include cows in that category?—No; milch cows certainly cannot be included, because they are kept in stalls or sheds, and it is an interesting fact that there are two classes of animals kept exclusively for use as human food—cows and sheep—which suffer to a very different extent from tuberculosis. Sheep roam about in perfect freedom, whereas cows are brought together in sheds and stalls for milking purposes, and are frequently found to be infected by tuberculous matter. Sheep, which are generally left to roam about on the hillside and in the fields, are rarely infected with tubercle.

976. Do you think that that consideration may explain the difference in the frequency of tubercle in cattle, and tubercle in sheep, when they are taken to the slaughter-house?—I think that it is quite sufficient to explain it.

977. Do you think that if cows and sheep were pastured together during their whole time of life, when they were brought to the slaughter-house they would be found to be equally tuberculous?—Yes, I think it is very likely. If the sheep were confined in the same way that the cows are, in close sheds and stables, the tuberculosis when once started would spread with as much rapidity as it does now among cows. On the other hand, in the case of cows I believe that if you took a herd quite free from disease, and kept the animals under the conditions in which sheep are generally kept, namely, in the open, they would very rarely become tuberculous. I look upon the close confinement in sheds, stalls, and stables as one of the great factors in the transmission of the germ from one animal to another.

978. (*Chairman.*) Confining them together in sheds and stalls is, you think, one great reason why cows catch the disease from each other?—Yes.

979. The infection is transmitted from one to the other?—Yes.

980. Then is it your hypothesis that no cow would catch the infection unless some other animal which already had it gave it; would no animal get it unless others had it?—No; that is entirely the point. They might catch it from the man who attended upon them; but I think it highly improbable, in the case of herds kept altogether in the open, that one animal would transmit the infection to another.

981. (*Dr. Buchanan.*) Is it a fact that cattle pastured on the hillside, as sheep are, pastured do not become tuberculous?—I am afraid that I cannot give you any facts upon that point; but I believe it is a well-recognised fact that it is the cattle which are most closely confined that are the most frequently infected with tuberculosis.

982. Then if you were to make experiments with cattle and with sheep in the way of inoculation, would there be any noticeable difference between the two? —Would there be any difference in the one case and in the other in the liability of the cow or the sheep to become tuberculous?—I am afraid that I cannot answer that question with any authority.

983. You were speaking just now of wild animals in durance and of their liability to become infected with tuberculosis. Is the quality of the food of much importance as a factor? Do the carnivorous animals suffer more than the omnivorous?—I believe that the herbivora suffer in a larger proportion than the carnivora; from which fact, I draw the deduction that the disease is more liable to infect animals through the air than through the food they eat. In other words, even in regard to wild animals kept in confinement and supplied with food which must frequently be largely infected with *tubercle-bacilli*, they do not in the case of carnivorous animals contract the disease as readily as herbivorous animals. I deduce from this fact that they become infected more through the air they inhale than through the meat they feed upon, and that consequently *tubercle-bacilli* in the air are more likely to infect people than the food they eat.

984. (*Chairman.*) Then I take it that you agree with a previous witness that we need not feel much alarm as to the chickens and fowls we eat?—I confess that I am not very much alarmed myself in regard to the possibility of contracting infection from drinking tuberculous milk or eating tuberculous meat. At the same time, I think it would be well to have the facts thoroughly examined in order to see whether anything can be done. My own opinion is, however, that a great deal more might be done by preventing infection in the air, and by getting rid of the evil of overcrowding.

985. (*Prof. Brown.*) There are only one or two questions I should like to ask you, Dr. Squire. It was stated in 1888, in the medical journals, that Dr. Latham, in giving the Harveian oration before the Royal College of Physicians, asserted that consumption had decreased in a quarter of a century by

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20 per cent. Is that a matter which has attracted your attention?—Oh, yes. The amount of consumption has very much decreased within the last quarter of a century. It has decreased very much indeed in recent years, and I think the decrease is due largely to the increased hygienic conditions of the work in which the people are employed. For instance, in the knife-grinding establishments, and the wool-sorting places, and in most of the occupations in which dust is thrown off, means have been taken to drive away the dust from the work-rooms instead of letting it remain in the air and find its way into the lungs of those employed. In that way a predisposition to take the disease has been prevented. There has also been a marked decrease in the overcrowding of the people in their habitations. Some of the apparent decrease may be due to more exact registration.

986. Can the same thing be said in regard to cattle; that is to say, can it be asserted that tuberculosis has decreased or is the contrary the fact?—I am not able to say of my own knowledge. I only know that one hears a good deal more now about tuberculosis in cattle than one did formerly. There may be a less amount of it, but that it is a matter which has become a little more prominent. However, I know very little about it of my own knowledge.

987. If you were told, as I may venture to tell you, that consumption or tuberculosis among what may be called shed animals—the animals you have spoken of as being more likely to transmit the disease from one to the other,—has largely increased, as far as my own observation goes, within the last few years, would it strengthen your suggestion that the risk to mankind from the consumption of milk and meat is comparatively slight?—That would induce me to say that unless some means can be found to prevent the increase of tuberculosis among shed animals, we are certainly leading up to a stage when the risk from eating flesh and drinking milk may become a very serious matter.

988. But there is one circumstance which you admit, namely, that consumption in human beings has decreased concurrently with an apparent increase of tuberculosis among cattle in sheds?—Yes.

989. Does not that circumstance suggest that the eating of these cattle—the majority of which would be eaten by the poorer class of people, because they would be animals in poor condition—can hardly have had much to do with the development of consumption in human beings?—My point is that there is a large amount of infection in the air, and that that is by far the largest factor in the causation of tuberculosis in human beings.

990. But if the disease has increased among various kinds of cattle that come into general consumption, would it not strengthen the view that the disease is not transmitted to human beings, in any large extent, through the meat which they eat, or the milk they drink? — Yes, it certainly strengthens that view, because the amount of consumption has been diminished, although the amount of tuberculosis in cattle has not diminished but on the contrary has increased. It would therefore appear, as the total amount of disease among human beings is less than it was, that most of the infection has been occasioned through inhaling air impregnated with the *tubercle-bacillus*, and that, as I said before, the hygienic conditions in which the people live have been improved.

991. Do I understand you to say that you do not think it desirable to prevent or limit the consumption of the tuberculous products of animals?—I should be content to try and limit the causes of tuberculosis in the animals themselves by keeping down the number of animals kept in one place, which at present in all probability contract the infection by being confined with other cattle which already have it. I do not know that I can go further than that. I should certainly feel disposed to pay attention to the condition of the animals rather than to any regulations with regard to the use of their flesh as meat.

992. Would it not be difficult to supply regulations for the stalling of cattle?—I take it that it would be quite possible to inspect the stalls for cattle in the same way that common lodging-houses are now inspected, and to provide that only a sufficient number of animals are kept in them.

993. Are you aware that there are statutory powers, at this moment, to limit the number of animals confined in stalls, but that there is no power to lay down regulations as to the mode in which the sheds and stalls shall be constructed?—No doubt it is a most important point, not only to limit the number of animals in a stall, but to provide the amount of air in cubic feet which shall be given to each. The air ought to be kept as pure as possible.

994. Do you think that it is more important to prevent the spread of disease among the living animals than to take measures to prevent the transmission of tuberculosis by the consumption of diseased meat as food by human beings?—That is certainly my opinion, in the small amount of information I have been able to get as to the effect of the consumption of tuberculous meat.

995. (*Dr. Payne.*) There is only one question, Dr. Squire, which I desire to ask. I think you stated that, in your opinion, many children get tuberculosis in their infancy in consequence of drinking tuberculous milk?—Yes.

996. The diseases they more commonly get when they are fed upon other food are another class of diseases?—Yes.

997. Have you had any experience which enables you to say that they suffer more from tuberculous disease when they are fed upon milk than when they are fed upon other food?—I think it is impossible to say that.

998. Why?—Owing to the fact that you cannot find a child who does not take milk as a large proportion of its food.

999. You have no statistics upon the point? — No; but I never heard of any child who was brought up without milk of some kind.

1000. Then it becomes impossible to draw a distinction between milk as an article of food, in the case of young children, and food without milk?—Yes, I think it is almost impossible to draw a distinction except in this way. What you may call abdominal phthisis is far more common among children than it is in adults, and children take a large amount of milk and only a small amount of meat, if any. The contrary is the fact in regard to adults: they take a much larger quantity of meat than milk. The inference, therefore, is that milk is a more powerful agent than meat.

1001. (*Chairman.*) Would you say that the gentlemen who have to do with a great hospital for consumption, such as Brompton, would coincide with you in your view that there is no raging controversy in regard to the injurious effects of eating tuberculous meat?—I think so; there is no raging controversy. I may be more advanced than some others in accepting the *tubercle-bacillus* as the necessary cause of consumption, and in maintaining that you must have the entrance of the *bacilli* into the body before you can get the disease. But beyond the fact that I take the whole of the consequences of accepting the bacillary theory, I think the profession to which I belong would agree with me generally.

The witness withdrew.

Adjourned until Monday November 24th, 1890, at 2.30 p.m.

NINTH MEETING.

7, Whitehall Place, S.W., Monday, November 24th, 1890.

PRESENT:

THE RIGHT HON. THE LORD BASING presiding.

Dr. G. BUCHANAN, F.R.S.
Dr. J. F. PAYNE.
Professor J. B. SANDERSON, F.R.S.

Mr. LEOPOLD HUDSON, *Secretary*.

Dr. T. Barlow, M.D., F.R.C.P.

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Dr. THOMAS BARLOW, M.D., F.R.C.P., Physician to University College Hospital, London, and to the Hospital for Sick Children, Great Ormond Street, London, called in and examined.

1002. (*Chairman.*) We know, Dr. Barlow, your repute as a physician. Will you state, so that it may be taken down by the shorthand writer, what is the position you occupy?—I am one of the physicians in the University College Hospital and I am also physician to the Hospital for Sick Children, in Great Ormond Street.

1003. How long have you been physician to the Great Ormond Street Hospital?—I have been attached to the hospital as assistant physician and physician for the last 16 years.

1004. Then I may take it for granted that within that time an immense number of cases of tuberculous disease have passed under your notice?—Yes, a very great many.

1005. Can you give us any idea of the number of cases and also of the number of beds which are under your supervision?—I do not think I could trust myself to give you accurately the number of cases which have come before me; but I may say that I have in my ward 21 beds which are always under my observation.

1006. I presume that what passes in the hospital generally is more or less under your observation?—No; only so far as my own cases are concerned.

1007. Then you are only one of several physicians?—That is so. I am only one of three.

1008. (*Prof. B. Sanderson.*) But I believe you have a considerable number of out-patients?—I used to have a very large out-patient clinic, and as assistant physician the number of patients who passed under my cognisance would be about 200 per week.

1009. (*Chairman.*) Two hundred a week?—Yes.

1010. Then during the last 16 years thousands of cases must have passed under your notice?—Yes, I think I may fairly say so.

1011. The foundation of this inquiry is the question of the identity of tuberculous disease in animals and man. You are aware of that fact?—Yes.

1012. And the revelations which have been made upon that subject have happened within your experience?—Quite so.

1013. Do your experience and observation enable you to say that you thoroughly agree with the new views in regard to tuberculosis which are suddenly taking the world by storm?—Yes, I think they do, as far as I am able to judge.

1014. Then you hold that if a child or a grown-up person has tuberculous disease or consumption in the intestines or in the lungs it must have been contracted by a poison, and could not have arisen in any other way; I mean that it must have been produced by an infection?—That is certainly the direction in which experimental investigations tend. At the same time, I do not think I should feel justified in committing myself to a decided opinion of that kind as a positive fact. All I will say is that that is the direction towards which my observations tend.

1015. I think that the witnesses we have already examined, or, at any rate, some of them, go so far as to assert that, just as typhoid fever proceeds from infection, inhaled, imbibed, or ingested, so tuberculous disease must enter the body in a similar manner, before any human being can be killed by it. Is that your opinion also?—Well, that is the direction of modern belief.

1016. It is the general view of scientific inquirers?—Yes, undoubtedly.

1017. You do not go so far as to say that the theory is as yet fully established?—No; I am not prepared to say that it is as fully and thoroughly established as the parallel instance you have mentioned of typhoid fever.

1018. What I meant, by referring to typhoid fever as a parallel case, was that it is parallel in so far as no one can have consumption, as tuberculosis is ordinarily and vulgarly called, who had not been infected *ab extra*?—Well, that is undoubtedly the direction towards which observations tend. But I should not feel myself justified, on clinical grounds, in making that absolute statement or in asserting that it has been proved up to the hilt.

1019. Of course it would be a very difficult thing to prove in that way?—Certainly, although it is quite reconcileable with the fact that tuberculosis has become developed in persons of a consumptive tendency. I am certainly of opinion that the doctrine now put forth has been to a very large extent established by observation.

1020. If the tubercle which causes all the mischief arises from a bacillus, does it not follow that the bacillus must come *ab extra*, and that it could not be developed in a patient from what I may call his own resources?—I think there are a good many modes of interpretation in regard to that doctrine. At any rate there are a good many conceivable modes of interpretation; but I frankly admit that my view would certainly be in the direction you have indicated. At the same time I do not consider that it is a completely proved doctrine.

1021. To come more closely to the point which concerns us in the present inquiry, in your immense experience have you ever seen cases, whether among children or adults, in which you have had reason to believe that the disease was contracted by eating meat or by drinking milk from animals which were infected with tuberculosis?—No, I cannot say that I have.

1022. May I ask if it is your habit to go back in every case, and inquire how the disease originated?—Well, not in every case; but of course since these experimental investigations have been published—many of them being of a very striking and important character—it is a matter which has been much more closely inquired into.

1023. If a case came under your observation in which a healthy youth, or a healthy grown up person, *Dr. T. Barlow, M.D., F.R.C.P.*

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or even a healthy child was suddenly smitten, just as he might be smitten with scarlatina, by a disease which was tuberculous, it would strike you that it was unusual, would it not?—You say suddenly smitten.

1024. Yes, a tuberculous disease suddenly developed?—Well, I do not think I can go to the extent of saying that such an occurrence would be unusual. Very often, at any rate, not unfrequently, a tuberculous disease comes on in a very sudden way. But far more commonly the disease has been insidiously working its way, and there has been a preliminary failure of health.

1025. It is the fact, I believe, that formerly there was supposed to be a hereditary predisposition. Do you coincide in that view?—No, I do not think so. I hold a different opinion as to the hereditary nature of the disease. The view I have taken of late years is that the only thing hereditary predisposition to consumption could do would be to induce a delicate build of body that would not have in itself sufficient strength to resist an attack of tuberculous disease. I would not say that the disease was inherited, but that it would be more readily acquired by a person of a delicate build of body.

1026. That is very much what we have heard from other witnesses. I take it that in such cases there must be an invasion of the tubercle?—Yes, I should certainly say so. There must be an invasion of the tubercle.

1027. I suppose that your special experience has been among children?—Yes, but I have seen a good many adults also.

1028. Of course it is more likely that the drinking of milk would convey the germs of the disease than the eating of beef or mutton?—Yes, I should say so, decidedly. It would be very probable.

1029. You have seen a very large number of children afflicted in that way?—Yes.

1030. They are I suppose more generally affected in the stomach or in the digestive organs than in the lungs?—I can hardly answer that question offhand. It is one which requires careful consideration. There is a group of cases in which the predominance of the disease is in the abdomen. But the disease is one which tends to generalise itself and there are other cases in which it manifests itself in the digestive organs. In the abstract in your possession I have tried to draw a distinction between these two groups of cases.

1031. Do I understand you to say that the frequency of cases of abdominal tuberculosis existing among children as compared with adults, suggests that the disease has started in the alimentary canal?—Yes.

1032. Would not such cases involve, according to our present theory an invasion of the infection?—Yes, it would, certainly.

1033. Supposing that it be so, have you always been of opinion that the disease has been induced in many cases by the drinking of improper milk—I mean of diseased milk?—Not always, it has been a very new suggestion to us, I do not think that our minds have been always sufficiently alive to that point.

1034. What do you think now?—I think that the investigations which have been made have a very important bearing upon the subject and that it is one which commends itself as a possible mode of invasion.

1035. May I ask you if you ever in any special case ascertained what milk the child had been using, and then going back upon the milk, found out that it was tuberculous?—No; among the poor it would be almost impossible to do that.

1036. There is another question I wish to put to you which I have already put to other witnesses and upon which I desire your opinion, having regard to the extensive nature of your experience. We have heard a great deal in regard to infantile mortality from tuberculosis?—Yes.

1037. And especially among the children of the poor?—Yes.

1038. We have been told that in many cases such children do not suffer from drinking poisonous milk, but that to a large extent they are fed upon other substances?—That is so.

1039. Then is the disease which follows from the feeding of children upon other substances than milk the same tuberculous disease?—Yes.

1040. And may be presumed to be contracted in the ordinary way from infection?—I do not quite follow the question.

1041. I put it to you that many children, and especially the children of the poor, are supposed to be injuriously affected in health, owing to the want of proper nourishment from milk?—Yes.

1042. Are children of that class affected in the same way as the children of the rich, or whatever it may be, who may have contracted tuberculous disease from the milk with which they have been nourished?—I do not think that in the present state of our knowledge we can draw any distinction.

1043. I think the returns show that in Leicester there has been a very high mortality among children?—Chiefly from infantile diarrhœa, I think.

1044. (*Dr. Buchanan.*) I do not think there has been any remarkable mortality in Leicester among children, except in the autumn quarter?—Yes, and, as I said, that is attributable to diarrhœa.

1045. (*Chairman.*) Is tuberculosis very common among the children of the London poor?—Yes, it is very common indeed.

1046. Is that presumably among children fairly grown and nourished on milk or in some other way?—That is a question which it is very difficult to answer. Indeed it is one which it is impossible to answer. Most of the children in London get milk to some extent. I do not think it is a common thing to have children brought up entirely without milk. A good many are brought up upon artificial food, with very little milk added. I think, however, that it would be very difficult to find any case where no milk at all was given during infancy.

1047. Have you had any special reason in the cases which have come under your observation, to suspect the milk?—Do you mean that I have had reason to suspect the milk as the cause of the tubercle.

1048. Yes?—No, certainly not. It is a matter which we have not had very much before us till of late. I ought, however, to add that in London, for the cows kept in the London dairies, it is alleged that tubercle is common.

1049. Have you ever analysed the milk supplied to the children in the hospital?—We have had it analysed.

1050. Have you ever found *tubercle-bacilli* in it?—No, I think not.

1051. Do you take any special precaution in regard to it?—Yes, we always boil it.

1052. You boil it?—Yes, we have done so for some years.

1053. Do you think that is an excellent precaution for people to take generally?—Yes, I am sure it is.

1054. We know that milk is apt to convey infection of another sort?—Yes, it is very apt to do so. Since the result of the recent experiments has been published we have been most emphatic in regard to the boiling of the milk.

1055. Do you think that boiling destroys the liability to convey infection?—Yes.

1056. However the mischief is done you do this in order to secure the safety of the children under your care?—Yes.

1057. In the notes which you have handed to the Commission, you say a good deal about the injurious results of overcrowding and insanitary arrangements?—Yes.

1058. But if the theory which I have been pressing upon you is absolutely well founded, no overcrowding would in itself bring about this specific disease, unless

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the germ were inhaled ?—I think it would make a tremendous difference.

1059. In what way ?—All these things are important factors and would make an important difference.

1060. How ?—In this way ; they render the body much more liable to attack and when attacked there would be less power of resistance.

1061. Then am I to deduce this moral, that whatever may be done by means of boiling, roasting, and analysing the milk and meat supplied for food, one cause of infection by tuberculosis you would say consists in the general unsanitary condition in which people live, and you think that that is a matter which is of still greater importance ?—Certainly, that is my opinion.

1062. In your opinion people living under such conditions are more likely to be attacked by the disease than if they were living under more perfect sanitary conditions ?—Yes, I think so.

1063. Would the same observation apply to the suggestion as to hereditary tendency ?—Yes.

1064. It would predispose a person to receive infection ?—Yes.

1065. The new theory in regard to consumption is that consumption is not inherited ?—That is so ; but even if a person had what you term hereditary predisposition and he were living under good hygienic conditions he might, to some extent, snap his fingers at the disease.

1066. Supposing that *tubercle-bacilli* are around us, in the air we breathe, in the meat we eat, and in the milk we drink, healthy people of the ordinary sort would not be susceptible or would be less injuriously affected ?—They would be less susceptible. I cannot say that they would not be susceptible.

1067. During the 16 years that you have been at the hospital has there been any diminution in the quantity of the disease ?—I cannot answer that question, I can only say there is a general belief that it has diminished in London.

1068. Are you aware of the great pains which are taken in Copenhagen to improve the condition of the meat offered for sale ?—No, I am not aware of the regulations adopted in Copenhagen.

1069. (*Dr. Buchanan.*) I wish to know, Dr. Barlow, how you would classify the tuberculous diseases of children ?—I have given some consideration to that subject in the light of the present inquiry, and it has suggested itself to me that there are two practical groups.

1070. Two groups into which the tuberculous diseases of children may be classified ?—Yes. I do not know whether they are important in a pathological point of view, but I think they are in regard to the origin of the disease. The two groups which I have chosen, are, in the first place, the cases beginning with the abdomen, in which you get the predominant disease in the mesenteric glands ; cases where the disease of the mesenteric glands is out of proportion to the affection of the bowels. That class of cases may have a special bearing upon the question of milk infection.

1071. And then there is a second group of cases ?—Yes, the other group to which I wish to draw attention consists of cases in which the disease begins in the chest cavity, following in the wake of acute diseases. These are the cases which, in my opinion, bear on the question of overcrowding and faulty hygiene generally. I have been much struck with the number of cases of tuberculosis which have been grafted upon measles and whooping cough. I think these two groups ought to be separately considered.

1072. Would not the latter class involve the finding of the *tubercle-bacillus* ?—Yes, eventually, but not primarily. Perhaps my answer to the question requires a little modification, but the view I am inclined to take is, that when in a case of measles we get a damaged, collapsed, or indurated lung, we are liable to have *tubercle-bacilli* grafted upon it.

1073. Have you particulars as to the growth of the tubercle ?—Yes.

1074. What would you say in regard to the brain evidences of tubercle ?—I should not think that the brain cases are worthy of being made a separate group for the purposes of this inquiry.

1075. What is your reason for coming to that conclusion ?—It is because it is a condition which might supervene in any other form of tuberculosis, and it commonly does supervene, as an accident, so to speak.

1076. You do not see tubercular meningitis as a separate form of disease ?—No, except very rarely.

1077. Do you see much of tuberculous disease of the bones ?—Yes, I have seen a good bit of it.

1078. In that case may I ask whether you regard it as a primary or a secondary complaint ?—That is a very difficult question to answer. I think it may be either primary or secondary. It might be looked upon in two or three ways; for instance, as a tuberculous invasion upon the top of some simple damage in a subject who was particularly liable to an attack of the disease, in consequence of possessing an hereditary tendency, or it might be taken also as, the result of, the direct invasion of *tubercle-bacilli.*

1079. I quite understand. You were telling us in regard to the intestinal mischief that when it commences, when the tubercles begin to form in the intestines, they are more likely to be related to the milk or meat tubercle than where the lesion makes its appearance in the lung, or in the brain, or in the bone ?—Yes, I think so.

1080. Do you judge that there is much tuberculosis which begins in the lung ?—In children ?

1081. Yes, in children ?—I think it appears in children in the lung often as a secondary complaint. I am of opinion that the appearance of tuberculosis in the lung of a child is secondary, and follows upon the dregs of some other disease, so to speak ; but if there is general tuberculosis the bacillus may have established a footing in the lung as well as in any other part of the body. In cases of general tuberculosis, of course the disease tends to be tolerably equably distributed ; but the cases which have specially attracted my attention, and to which I have referred, have been cases where I have had reason to think that tuberculosis has supervened upon something else.

1082. You have spoken of instances which have come under your observation in which an attack of measles has run into acute tuberculosis ?—Yes.

1083. The appearance of the tubercle after an attack of measles would be tolerably rapid, would it not ?—Yes.

1084. Are these cases in which you would regard the lung as having been directly infected by the inhalation of the *tubercle-bacillus* ?—Yes, I think so. Dr. Woodhead's observation and clinical investigations have, I believe, tended in that way. I think the bronchial glands and the lungs seem, as it were, to have been playing battledore and shuttlecock with one another. In the first place, the lymphatic glands connected with the lung seem to be more infected with tuberculosis than the lung tissue itself. In the second place, the infection of the lung becomes secondary from the infection of the glands. It is a question that is difficult to understand, but it certainly seems that a damaged tissue has means of conveying tuberculous matter into other parts of the body without showing much signs of the disease in itself. The tuberculous material, being once landed in the lymphatic glands, so to speak, is capable of being subsequently disseminated.

1085. You mentioned the intestinal glands. Have you seen distinct tuberculous matter there ?—Yes, I have been very much struck at times, especially in the case of young children, with the extent to which abdominal tuberculosis has been developed, the mesenteric glands having been largely infected with tubercle, whereas on the other hand the damage to the lung has been very slight.

1086. You are speaking of cases in which the lung has not contained any considerable amount of tuberculous deposit ?—Yes ; sometimes I have noticed that the lung has been very little affected.

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1087. You have not seen any frequent relation between mesenteric disease and the rapid deposit of tubercle in the lung?—I have seen cases where the bronchial glands have been seriously affected and the mesenteric glands also, with comparatively little tuberculous deposit in the lung itself. That is a point which is constantly meeting one in the face.

1088. You have seen it constantly?—Yes, I have noticed the way in which there can be an extensive deposit in the lymphatic structures with very little in the peripheral parts which supply them. This gives a little conceivability to the idea that the tubercle may enter with some other disease and yet not occasion a very large amount of damage to the tissues, and may find its nidus in the lymphatic structures, slowly effecting a habitation there.

1089. It must come rapidly into the lung circulation, and it would be likely to give rise to tuberculous deposit in the lungs almost of necessity if it once got taken into the lymphatic system of the abdomen?—I am only speaking of what I have actually seen.

1090. Do I understand that that is a matter which does not suggest itself to you?—No, it does not. Of course bacilli, when they have once found an entrance into the system, are widely and extensively disseminated; but I should say that the cases are not rare in which the infection of the lungs is only very slight, the disease being confined to the lymphatic structures.

1091. You are not able then to give us anything approaching to statistical evidence as to the relation between the eating of tuberculous food and the infection of the abdomen with tubercle?—No.

1092. Neither in the case of adults nor of children?—No, I cannot.

1093. (*Professor B. Sanderson.*) Dr. Barlow, I just wish to ask one question: Can you tell us anything as to the difference in the time of life at which the invasion occurs in the two groups of cases of tuberculous disease which you have distinguished from one another? Perhaps I ought to say, instead of "time of life," the period of childhood?—That is a very important point, no doubt, but unfortunately the *post mortem* inspection of young children—children under 12 months old—has never been thoroughly done because they are not generally taken into the hospital. But I have made a great many examinations of infants—patients who have been visited at their own homes, and I must say that I have found a great deal more tuberculosis in children under 12 months old than I had any idea of. But the cases which I have seen have been cases of general tuberculosis. It has been the general condition—not only abdominal tuberculosis, but tuberculosis throughout the system ending in acute tuberculosis all over the body.

1094. Both pulmonary and serous?—Yes. I have gone into the matter with special reference to this inquiry. In children under 12 months old one might expect that the disease would be limited to the abdominal organs, but I am bound to say that those whom I have examined have had extensive general tuberculosis all through.

1095. Even the very early cases?—Yes, even the early cases. In fact it has been more like animal tuberculosis.

1096. I think I understood you to say that you have never observed congenital tuberculosis?—I have never seen congenital tuberculosis. The earliest case in which I discovered the existence of tuberculosis was the case of a child four months old.

1097. (*Dr. Payne.*) Four months old at the time of death?—Yes, four months old at the time of death. It was difficult to say when the disease commenced.

1098. (*Prof. B. Sanderson.*) You are not disposed to say that these early cases were attributable to congenital tuberculosis?—No; I should hardly think so.

1099. You express, on the contrary, a strong opinion as to the influence of local conditions in determining tuberculosis?—Yes.

1100. Would you put it in this way: that local conditions have aggravated a disease already existing, or that it is probable that infection may have taken place?—From the surroundings?

1101. Yes?—That is a point which would require consideration. The form it has taken in my mind is rather this: that the existence of tubercle is very common among the children of the poor. Among children dying of all kinds of disease I have found some tuberculous deposit in a great many of them, and therefore the view I take is, that there are probably a very large number of poor children who have these conditions to a greater or less extent, with the chance of the disease becoming latent; but if the conditions are not good, then there is a chance of the dissemination of the disease.

1102. (*Chairman.*) The dissemination of the disease?—Yes. In the examinations I have made I have found that in the case of weak and emaciated children the existence of tuberculosis in any part of the body is liable to be followed by its general dissemination, owing to the influence of the surroundings; but it is my view that if the surroundings are moderately good, there is a possibility of the child surviving. If the surroundings are bad and faulty, the chances are that the disease will disseminate itself into the system generally and result in acute tuberculosis.

1103. (*Prof. B. Sanderson.*) So that the influence of the surroundings in such a case is to aggravate the tuberculous disease which may have been already existing?—Yes, I think so.

1104. Can you say anything about the relation of this early tuberculosis to parentage?—That is a question which there is great difficulty in answering. In the first place there are a good number of cases in connexion with which there has been no parental tuberculosis, or, at any rate, no parental tuberculosis which can be ascertained in the ordinary way. The parents are living and healthy, as far as one can see without a minute examination, and they have no signs of being infected with tuberculosis. I should say that there have been an enormous number of cases in which no parental tubercle could be traced by an ordinary inquiry. The difficulty of the question is this: accepting what I have just said, that the existence of tubercle is very common indeed among the poor at some period of life, it is conceivable that one or other of the parents, who now appear to be perfectly healthy, may, at some former period, have had some tuberculous deposit, so that until an opportunity is afforded of post mortem examination of the parent, no absolute conclusion can be formed.

1105. I judge from what you have said that your impression is that tuberculous disease in children, in the greater number of cases, springs out of a non-tuberculous acute disease?—I do not think the experiments have been long enough before us to enable me to answer the question. A satisfactory solution may be found after careful inquiry and clinical proofs, especially in the case of infection by milk. But I do not think the experiments have been undertaken sufficiently long to enable one to speak confidently upon the matter. At the same time, I must say that I think that tubercle intervening in the lowest conditions of health will account for a great deal of the disease and its consequences.

1106. (*Dr. Payne.*) You have had great experience, Dr. Barlow, in examining the bodies of people who have died of tubercle?—Yes, I have.

1107. I understand you to say that some portion of the bodies you have examined showed the existence of acute tuberculosis, whereas in others it was only latent?—Yes.

1108. Where the tubercle was only latent, was there anything to show in what part of the body the disease had begun?—Yes I think so, but I cannot say positively.

1109. You do not feel quite certain?—Well, I think I may say yes. In regard to the question of the primarily affected structures, I think the tubercle may have been originally deposited in some particular

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portions, but has left less traces of its ravages than in the lymphatic glands, which might show it more prominently.

1110. At all events, it would show the relative date of the disease ?—Yes, it would, no doubt.

1111. Do you think, if the statistics of the *post mortem* examinations which have been made in the Children's Hospital and in other hospitals were collected, and the cases of tuberculosis analysed, that such statistics would show in what proportion of cases the tuberculous disease began in the abdominal organs, and in what proportion elsewhere ?—It is difficult to say that, but I think they might in a very general way. At all events, they would show the predominance of the disease in one group of organs or the other. But of course it would tend to generalise itself, and a conclusion could only be arrived at in a very broad way.

1112. Still, in that way it would show whether it was one disease or the other ?—Yes, it would.

1113. Then do you think that if we had statistics of that kind collected, say, of the *post mortem* examinations at the hospitals, any light would be thrown on the question whether the tuberculous disease began in the digestive organs or elsewhere ?—I think they would throw some light upon it.

1114. What do you say is the earliest date at which you have got signs of recognised tuberculous disease in a child ?—I have spoken of a child who died at the age of four months, in whose body tuberculous deposits were found. I should say that in that case tuberculous disease had existed for at least a month.

1115. Have you ever noticed tuberculous disease in a child which has been entirely fed upon its mother's milk ?—I am not able to say that.

1116. (*Dr. Buchanan.*) Perhaps you have not seen many cases of that kind ?—No.

1117. (*Dr. Payne.*) You do not remember any case in regard to which you can speak positively ?—No, but I have seen children who have had tuberculosis when they were at the breast. I remember the case of a child 10 months old which undoubtedly had tuberculosis.

1118. Did you ever have a case of tuberculous disease in the mammary glands in women ?—No, I have never seen it.

1119. Then you have never had any evidence of tubercle being conveyed to infants by lactation ?—No. I may add that the case of the child of four months old which I have already referred to was a very remarkable one. The first thing that occurred was a very bad attack of stomatitis. Then came enlarged glands under the jaw, and then there was a general invasion of tubercle.

The witness withdrew.

Inquiry adjourned until Wednesday, 3rd December 1890, at 2.30 p.m.

TENTH MEETING.

7, Whitehall Place, S.W., Wednesday, December 3rd, 1890.

PRESENT :

THE RIGHT HON. THE LORD BASING presiding.

Professor G. T. BROWN, C.B.
Dr. G. BUCHANAN, F.R.S.

Dr. J. F. PAYNE.

MR. LEOPOLD HUDSON, *Secretary.*

r. R. D. well, M.D., F.R.C.P.

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Dr. RICHARD DOUGLAS POWELL, M.D., F.R.C.P., Physician-Extraordinary to Her Majesty the Queen; Consulting Physician to the Brompton Hospital, and Physician to the Middlesex Hospital, called in and examined.

1120. (*Chairman.*) Will you tell us exactly what your position is in connexion with the Brompton Hospital ?—At the present moment I am one of the consulting physicians.

1121. But I take it that you have had a long experience in a different capacity ?—I have for something like 22 years have been an active member of the staff both inside the hospital and among the out-patients.

1122. Then we cannot doubt that your experience of consumptive patients is something enormous ?—I think I may say that it is very considerable.

1123. Have you anything in the nature of figures which you can put before us as to the number of patients who have passed under your notice ?—Roughly speaking, I should think some 16,000 or 20,000 out-patients; and then for about 21 years I have had some 40 beds constantly under my care.

1124. Constantly full ?—Yes, constantly full.

1125. I presume you are cognizant of the views which have been gradually formed of late years upon the identity of tuberculosis as regards animals and mankind ?—Yes.

1126. Those views have been propounded or developed and brought to their present position long within your experience ?—Yes.

1127. But your experience goes back to a time when no such idea prevailed ?—Yes.

1128. Having been, as it were, an old stager, in reference to consumption, have you accepted the views which prevail now, or with what limitation ?—With regard to what ?

1129. The identity of tuberculous disease in animals and mankind and its communicability ?—Yes, I think I may say that I accept that view. I am, however, under the impression that there is a slight difference in the quality or nature of bovine tuberculosis and human tuberculosis.

1130. You have that impression ?—Yes, I have that impression, certainly.

1131. Are you generally aware of the nature of the experiments which have been made in the inoculation of animals ?—Yes.

1132. But of course we are very far yet from the critical question submitted to this Commission—in fact we have not approached it yet—namely, how far the consumption of milk and meat from tuberculous animals causes, as a matter of fact, or may be expected to cause, the disease in man?—Certainly.

1133. What do you say about that? Assuming all the investigations to be well founded, and the experiments to prove the communicability of the disease, is it the fact, in your judgment, that any danger exists in consuming meat bought in the butchers' shop or in using milk from the milk pail? Is there any appreciable danger as far as your opinion, founded on your own observation goes?—As far as it is founded on my own observation, I am bound to say that I have not met with any cases within my experience which would connect the two facts together. My knowledge of what has been going on in connexion with the scientific investigation of the matter makes me awake to the possibility; but so far as my own experience and observation are concerned, I am bound to say that they are not favourable to such a view.

1134. That was the next question I was going to ask you. You have not met, in the whole of your immense experience, with cases in which you had reason to expect or believe that the patient contracted the disease from eating tuberculous flesh or from drinking tuberculous milk?—No; I have not met with such a case.

1135. I take it that your experience has been rather among adults than infants?—Yes, within recent years. I was formerly connected with a children's hospital, but it was before the new observations came up. Of course one sees children among the out patients now, but Brompton Hospital is more especially for the reception of adults.

1136. Do you take any special precaution in regard to the meat given to consumptive patients or in boiling the milk?—Do you mean at the Brompton Hospital?

1137. Yes?—I think not; I do not think that any precautions of that kind are taken, but I can find out precisely, and let you know. I think that the milk in Brompton is not all boiled.

1138. At all events you have not had the question so impressed upon your mind as of such vital importance that you would recommend all the milk to be boiled?—No, certainly not.

1139. Do you think it is necessary to recommend that as a precaution?—No.

1140. Assuming that the milk or meat would constitute the source of infection, would not milk be more likely to convey it than meat?—Yes, I think so.

1141. Milk would more likely be the vehicle for conveying infection?—Yes, and it is very often taken raw.

1142. Is it not notorious that cases of typhoid fever have come from drinking infected milk?—Yes, *i.e.*, milk contaminated by impure water; but with regard to tuberculosis arising from milk one's *clinical* experience would go rather far in pointing to a negative. I am not aware, for instance, that young children are infected in that way. Phthisical tuberculosis is comparatively unknown in young children—I mean when quite infants, and deriving their nourishment from lactation.

1143. But there is a great deal of what we have heard of in connexion with tabes mensenterica of a tuberculous character, is there not?—Yes.

1144. In young children?—Yes, but not in suckling infants.

1145. Should you be inclined to believe that a tuberculous disease of that kind is occasioned by the greater use of milk among children?—Of course I cannot say that it might not be so, but I am not aware of the fact.

1146. You have never suspected it from anything you have seen?—I cannot say that I have. Tuberculosis of the bowels is almost unknown in young children.

1147. Unknown in very young children?—Yes.

1148. But not unknown in children from five to 10 years of age?—No, but it is not very common.

1149. Take the case of a child five years old, if in proper nurture it would have a great deal of milk for its food, would it not?—Yes.

1150. But you say it never has occurred to you, so that you can lay down that a liability on the part of young children to contract tabes mesenterica is occasioned by their use of milk?—It might be so, but I cannot say that it is.

1151. The way in which it has been put to us is this, it is now proved, they say, that consumption, or tuberculosis, can only be taken by infection, just as typhoid fever is taken by infection. In the case of tubercle it is due to a bacillus, and we are told that hereditary liability to the disease is a delusion; that however liable a human being may be to contract the disease, he will not get the actual thing except by inhaling or swallowing the bacilli?—Yes.

1152. If that is so, it may be argued that the use of milk by young children is attended with that danger?—I am afraid that I do not quite see the premisses of your question.

1153. Then will you be so good as to contravene them?—My ground is that we are all exposed to the liability. We have an abundant supply of tuberculous material in and around us. It is said that there are 50,000 organisms in a cubic metre of the atmosphere of Paris, and there may be the same in London, and among these organisms I take it that the tubercle bacilli more or less actively represented, so that I feel convinced, in my own mind, that I and all of us have plenty of bacilli in us and around us, so that if from any cause we become liable to their plantation we shall get them.

1154. Then you are not as much moved as the promoters of this inquiry have been, by the notion that very great risk is incurred by the careless eating or drinking of tuberculous food?—No, I do not think we run any great risk.

1155. That is a very important statement of opinion; you are of opinion, nevertheless, that whatever sanitary laws exist in the large towns, and in the country, which tend to induce greater care in the inspection of meat and in the management of dairies, having begun a certain amount of legislation of that sort, it would be well not only to continue it but to intensify it?—Unquestionably, if there be any tuberculous disease in milk or in flesh, it would be very improper, of course, to allow any one knowingly to consume it.

1156. I suppose that in your great practice and experience of disease you take care, in every case, to trace, as far as you can, the origin of the disease?—Well, I do take considerable care to ascertain, as far as possible, what was the beginning of the earliest failure of health, the hereditary disposition of the patient, and any of the conditions of life to which he may have been exposed.

1157. I think you have recently been to Berlin?—Yes, I have just come back.

1158. I do not propose to enter into the interesting subject of Dr. Koch's remedy, but as far as you could feel the pulse of public medical opinion in Berlin, do you think they are hopeful that care of the kind submitted to us as to the character of the meat and milk any impression can be made upon the quantity of tuberculosis in the world?—I think that the German physicians, generally, are very strongly impressed with the contagiousness of consumption. I went round one very fine hospital, and I was told that in all cases the mattress used by a consumptive patient is burnt after the patient goes away; so that they entertain the belief of the contagious nature of the disease much more strongly than we do.

1159. That is to say, contagious between man and man?—Yes.

1160. But they do not hold the same view, so far as you are aware, with regard to animals?—I should think they do, but I observed raw meat largely given to consumptive patients in Berlin.

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1161. You are aware, I dare say, that a very stringent system of supervision and interference with the natural course of trade has been going on in Copenhagen for the last three years?—I have heard so.

1162. You do not know anything personally or particularly about it?—No, I do not.

163. If we were unhesitatingly to accept as undoubted all the experiments which have been detailed in the reports and books we have seen as regards inoculation from animal to animal it would not alter your general disposition to believe that great danger may exist from eating tuberculosis meat?—Inoculation is one thing and disease derived from inhalation or the digestive process is another. The two are very dissimilar, my great difficulty consists in this fact: if milk were so dangerous to children who specially take milk, it strikes me as being somewhat curious that the disease is not more notably prevalent among young children, a large proportion of whom suffer from disease. Turning the matter over and over in my mind, I cannot say that I am at all convinced of the association between the two, as a matter of fact, statistics go to show that the offspring of diseased parents, especially where the inheritance is on the female side, acquire phthisis rather later than when they inherit it from a diseased father. Elaborate statistics have been prepared on that point by Dr. Reginald Thompson, drawn up from the records of Brompton Hospital.

1164. You do not find an excess of mortality among the children of diseased mothers?—No. Of course, when we have to deal with the children of sick mothers suffering from tuberculosis one would expect a notable excess of mortality among them from tuberculosis whilst still in infancy.

1165. I take it that if children inherit the disease, as you were just saying, from either parent, they inherit it at once from their birth, and the disease would appear immediately?—Yes.

1166. That would not account for the tendency on the part of children to contract phthisis at the age of five or six years?—I do not think the inherited disease of children at birth is ever like that of children who get the disease later.

1167. You do not think that they are born with bacilli in them?—No; there is no evidence of it.

1168. You spoke of the Germans, who are very advanced on this subject, treating their consumptive patients with raw meat?—Yes.

1169. Do you know whether the meat had been specially examined with a view to ascertain whether it came from a healthy animal or not?—I cannot say, but I think they must take some precaution of that kind. I was certainly struck at seeing plates of raw meat made use of.

(*Chairman.*) I will not detain you longer, Dr. Powell. I will wait and hear what the other members of the Commission have to ask you, and I may, perhaps, trouble you with a question or two afterwards.

1170. (*Dr. Buchanan.*) You made use of a phrase in one of your earlier answers, Dr. Powell, that seems to me to have a good deal of interest for our Commission. The Commissioners, as you may easily suppose, have to proceed very largely indeed by reasoning from the analogy of what happens in the case of the lower animals, in order to arrive at a conclusion as to what may happen in the case of a human being?—Quite so.

1171. We want very much to know how far we can trust these analogies. I notice that you said, using the past tense, you *had* an impression of a pathological difference between the bovine and the human tubercle. I presume you meant by this use of the past tense that you have come to think the two are very much alike, or more alike than you had originally thought them?—Yes.

1172. How would that affect your view as to the trustworthiness of the analogies drawn from the lower animals and applied to man?—Well, of course, there is a difference in authority as to the form of the tubercle in bovine tuberculosis and tuberculosis in man. That may be due to the altered structure of the two classes. I do not know that any essential difference has been found in the bacillus. My impression at the present moment is that the bacillus is practically the same.

1173. We are told so, but that there are some little differences in the morphology of the bacilli; and we are told so on good authority, I believe. But there remains the question of the trustworthiness of such analogies as we draw from the lower animals and venture to apply to a human being?—I did not mean to cast any doubt about that. I think the diseases are sufficiently analogous for that part to hold good. I do not feel justified in recording any views contrary to that, certainly.

1174. We are told, for example, of considerable differences in the behaviour of cattle and sheep in their proclivity to tuberculosis. Supposing that we learn that cattle are the more susceptible to tuberculosis by taking tubercular milk into the stomach, we should have to make an allowance for that difference between cattle and sheep before we proceeded to apply to sheep the experience derived from cattle; is not that so?—Yes.

1175. What allowance should we have to make for the case of human beings. Should we infer that what is true in regard to cattle is true also of human beings. Because we find, for example, that tuberculous cows' milk did the mischief to the calf, might we infer that tuberculous milk taken from a bovine source would also do harm to the human infant?—You might infer so.

1176. Have you had any experience about that matter?—My experience is that I have not been satisfied that I have met with cases in which the tuberculosis in the human subject has been started by the drinking of milk. I perfectly understand the great analogy between the two, but I gather that I am questioned now as to what one's experience is.

1177. (*Chairman.*) May I interpose a question here, if you will allow me. It does not follow that because tuberculosis is a matter of analogies the anatomy is the same in the two classes—animals and human beings. It does not follow, I apprehend, that the disease is the same. I think you rather put it in that way?—Yes.

1178. Take, by way of illustration, the case of smallpox. Whatever the disease is from which cows suffer, the analogy in the case of mankind, so far as that disease is concerned, takes, in fact, a different form. The results of vaccination are not manifested in precisely the same way in the two cases?—No.

1179. I mean that although the bovine disease may not be different from smallpox, it is manifested differently. Does not that consideration and illustration show how difficult it is to be quite sure that although this disease appears to be quite the same, it may be different in man and animals?—I think it shows by analogy that disease is communicable from animals to man by feeding under certain conditions, but I do not think the point has been experimentally shown.

1180. (*Dr. Buchanan.*) I was going to take another advantage of Dr. Powell's observations. You told us that you have observed the preliminary circumstances under which people fall into consumption, and that you have examined, among other things, the question of hereditary predisposition. You can tell us something of the proportion of cases which come into the hospital in which the persons who have been suffering from tuberculosis had a previous history of hereditary tuberculosis?—Yes, I think, statistically, that the proportion is as nearly as possible 48 per cent.

1181. About 48 per cent.?—Yes. One's impression will endorse that.

1182. With a history of tubercle in the father or the mother?—Yes, or in the direct blood line. Say from an aunt on the father's side.

1183. Have you found it more frequently on the father's side than on that of the mother ?—I have a note here upon that point, which I may perhaps be allowed to refer to. "Hereditary : 59 per cent. for "females, and 37 per cent. for males." That will give an average of about 48.

1184. Leaving 4 per cent. not accounted for ?—It is an average of a little more than 40 per cent. for both ; about 48.

1185. (*Chairman.*) Putting it in a proper way, about one-half ?—Yes.

1186. (*Dr. Payne.*) That is not altogether direct descent ?—No.

1187. (*Dr. Buchanan.*) The per-centage on the female side who have this family history of tubercle is 58 ?—Yes, 58 per cent.

1188. And 36 per cent. on the male side ?—Yes. That is the effect of the statistics of Dr. Reginald Thompson of cases derived from the Brompton Hospital. The other reports from the Brompton Hospital come to the same thing.

1189. You account for 96 per cent. Is the other fraction of no consequence ? What I mean is this : Is the remaining 4 per cent. made up by fractions of no importance, or is there another formula ?—You have misunderstood my answer. Taking 1,000 cases of phthisis, 59 per cent. are on the female side, or 37 per cent. on the male side.

1190. I thought you meant a given 100 cases of inherited tubercle ?—Oh, dear, no.

1191. (*Chairman.*) That was the noted condition ? Yes.

1192. (*Dr. Buchanan.*) It has reference, then, to a total number of patients ?—Yes. Roughly speaking, the percentage of phthisical inheritance is about 48 per cent., a little in excess of that for women, or a little within it for men.

1193. Would that proportion hold approximately for people of different ages ? In the case of a child, for instance, would there be much difference from this proportion ?—I should say not, speaking generally. I think the inheritance tends rather to distribute the current of disease.

1194. What is your own belief as to the value of the figures as evidence of the frequency with which the disease has been derived from the parent by the child ?—I am still strongly impressed by the observations which have been made as to the reality of inheriting a predisposition to phthisis.

1195. A predisposition to phthisis ?—Yes.

1196. And whatever that degree of predisposition to phthisis is, would you be prepared to regard it as sufficient to produce phthisis in the absence of infection obtained from outside ?—Well, as I said just now, under the ordinary circumstances of civilization, I take it for certain that there is ever present a possibility of receiving the bacillus, and that we have weak health on the one side and the plantation of the bacilli on the other, having for its result phthisis. What I mean is, that there is a proclivity on the one side, organs, for instance, that are predisposed by inherited or acquired defect to the reception of the bacilli. I am quite aware, from the experiments which have been made, that an animal subjected to the spray of a tuberculous fluid for a certain time will be almost certain to acquire tuberculosis. But the conditions of human life do not approximate to those of such an experiment, or allow of its being made.

1197. I think it is Mill who points out that when reasoning about causation we may be apt to omit from the argument some necessary causes or conceal them under the name of necessary conditions. For example, he puts some such case as this. If a person is drowned, and it is said that he is drowned because he could not swim, we do not mention the presence of water ; and yet water is a cause of drowning in the sense of being a *sine quâ non.* Are you thinking of the presence of the bacillus as being a cause of tubercle only in the same sense as the water in Mill's illustration ?—The tendency of the day is, perhaps, to speak of the bacilli, and to allude to the important conditions under which they become active and dangerous.

1198. I wish now to ask you to give the Commission some of your experience in connexion with the Brompton Hospital. What special precautions do you take to prevent the spread of a disease which is held to be communicable from patient to patient, or rather from patient to nurse, and from patient to doctor ? What precautions are taken in the way of disinfection or separation, and what precautions of a sanitary nature ?—The sanitary precautions now adopted in the Brompton Hospital, and adopted, of course, since one became aware of the existence of the bacillus, and so on, are to disinfect the sputa and the spitting vessels. Carbolic fluid, thymol, or sanitas, or some other disinfectant is put in the vessels used. Of late years the sputum has been taken down stairs and burnt instead of being put into the drains.

1199. That is the system now carried on ?—Yes, I believe so. I am not aware that the milk is boiled, but I cannot say with certainty. Beyond that, abundant air space is provided and good ventilation. I am not aware whether any other special precautions are taken.

1200. Are there any special precautions taken in dealing with the bedding and clothing ?—No, I think not. I presume you mean in the way of steeping them in disinfectants ?

1201. Yes ?—No, I am not aware of any.

1202. I presume they all pass through the ordinary processes of washing ?—Yes, I believe so.

1203. Is that done in the institution or not ?—I think it is not done in the institution. I think there is no laundry in the hospital.

1204. Do you think the Commission could get any evidence of the prevalence of tubercle among the washerwomen who work for the Brompton Hospital ? —I should think it might be desirable.

(*Chairman.*) How about the nurses ?

1205. (*Dr. Buchanan.*) I was going to ask Dr. Powell a question about the nurses. (*To witness.*) Can you learn anything about the people employed in washing the clothes for the hospital, or who have been employed there almost since their childhood ? I presume you know a good deal about the history of the arrangements there ?—I will make inquiry ; but to carry it out with any advantage to the Commission will require a great deal of time and care, or it would not be done satisfactorily.

1206. We should be unable to do it as satisfactorily as you can. Can you undertake to get us information on the subject ?—I will speak about it, and do all I can.

1207. Thank you. Are your nurses more liable than other people of the same age to become tuberculous ? — I think I can answer that question emphatically in the negative. At the request of Dr. Cotton returns were obtained by Mr. Edwards, a former resident medical officer, in regard to all the people who were or had been connected with Brompton Hospital,—nurses, porters, physicians, surgeons, and so on. It was found that the mortality from consumption was quite within the average of ordinary mortality.

1208. When was that inquiry made ?—The result is published in Dr. Williams' book. The information was published also by Dr. Cotton, a good many years ago now.

1209. The publication is since the time of the observations that have been made upon the bacterial relations of phthisis ?— The inquiry is quoted by Dr. Williams in his book. I am not sure that I have a reference to the place where the statistics are to be found, but I will find it out for you.

1210. I have only just one other question to ask you, Dr. Powell. Accepting the view that the entry of tubercle bacillus into the body of a patient is the means of infecting him or her with tuberculosis—accepting that view, may I ask you if you concur in the opinion which has been given to us by Dr. Klein, and some others, that the place at which the bacilli

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enter the body cannot be inferred from the local manifestation of the tubercles in one or another organ?—You mean that the bacillus may enter the stomach and find its way into the lungs?

1211. I mean that it may enter the stomach or the intestines, and yet the principal manifestation be in the lungs?—I think that is quite possible.

1212. You would not dispute that proposition at all?—No, I think not.

1213. It would be a great thing for the Commission if we could be sure that we knew for a certainty where the tubercle enters the body. We should then be able to reason much more confidently as to the effect of feeding with meat and milk?—Just so.

1214. (*Professor Brown.*) Here is only one question I want to ask, but it is rather an important one. It puts Dr. Buchanan's proposition in another form as to the proceedings of the Commission in regard to the evidence we are able to get. Clearly enough it must be entirely illogical supposing the Commission is satisfied from the evidence either that the meat or milk of tuberculous animals does or does not, by inoculation or otherwise, injure rabbits and guinea pigs fed on it, and in consequence should report that it would not be injurious to a human being fed upon it; would you, as a man of great experience, be satisfied with the conclusion of the Commission?—I should be greatly impressed by it, at all events.

1215. You would not think it strange or entirely away from the point?—You mean that it would not be strange to argue from the effect on guinea-pigs that similar results would be produced upon man?

1216. Yes?—I can only say that I should be greatly impressed by any evidence to that effect.

1217. I only wanted to know what you think about it?—I quite understand.

1218. (*Chairman.*) Perhaps you will come again, Dr. Powell, if we want to ask you any more questions?—Certainly.

The witness withdrew.

Dr. A. Ransome, M.D., M.A., F.R.S.

Dr. Arthur Ransome, M.D., M.A., F.R.S., Honorary Physician to the Manchester Hospital for Consumption and Diseases of the Throat, called in and examined.

1219. (*Chairman.*) Will you be so good, Dr. Ransome, as to state to the Commission, the position you hold in Manchester?—I am honorary physician to the hospital for consumption.

1220. That is a special hospital?—Yes, it is a special hospital for consumption and diseases of the throat.

1221. And how long have you been in that position?—About 12 years.

1222. How many patients are there there?—Do you mean how many are there immediately under my care?

1223. I mean what has been the average number of patients out and in during those 12 years?—That is very difficult to say, but we have an attendance on my day of about 200 out-patients. We have had as many as 230.

1224. We may take it that there are 200 out-patients constantly in attendance?—Yes; but that is merely on one day of the week.

1225. You do not speak for the hospital as a whole?—No.

1226. Only from your own experience?—Only from my own experience.

1227. How many beds are there in the hospital?—Thirty-seven.

1228. Under your charge?—No; there have been only about 10 under my charge, but I see them all.

1229. That is the measure and extent of your experience, and the number of cases you have under your charge?—Yes.

1230. Do you attend private patients as well?—Yes.

1231. Generally in connection with the same disease?—No, I am in general practice.

1232. Are you a thorough-going adherent to the newly-discovered view as to the communicability of consumption?—Communicability by means of the bacillus.

1233. Yes?—Oh, yes, I believe that it comes from without.

1234. Do you think that, however weak and sickly a person may be naturally, he does not become consumptive, except by inhaling, imbibing, or ingesting the bacillus?—Yes, as a general rule.

1235. You say that it is the general rule. Is it not the universal rule?—I should not like to deny the possibility of transmission by hereditary taint, but, originally, of course, it comes from without.

1236. Do you mean that infants are born with it?—I think that is possible.

1237. And if so, would it follow that they must rapidly show it? Would they grow to maturity with this inherited mischief in them, and then become consumptive?—I do not deny even the possibility of that. I do not believe it myself, but still I do not deny the possibility of it.

1238. Still, speaking generally, your view is that the disease comes from without?—Yes.

1239. Is that state of opinion growing gradually, or do you adopt it from experiments which have been quoted, and the statements which have been made by specialists?—I had come to that conclusion before the discovery of the bacillus, both from my own experience and from other evidence.

1240. Do you find that persons in attendance upon consumptive people get consumption?—The attendants in the hospital? I should say not.

1241. You do not think so?—No, I never saw such a case.

1242. Then, may I ask you if you can say, in a word, when you began to suspect that consumption was infectious, so to speak, if you found that it did not occur in such a very natural way?—I came to the conclusion that it might be acquired in that way, or usually was acquired, on account of the evidence obtained as to phthisis in the Army. I refer to the result of the Royal Commission which sat after the Crimean War. I also studied the experience of large towns, and the enormous spread of the disease in badly-ventilated tenements.

1243. Places which the bacillus would haunt, and in which they would lurk?—Yes, and possibly live. I think there is reason to believe that they cannot live under more healthy conditions for any length of time.

1244. Do you know, in your own experience, of any cases in which you have had reason to suspect or believe that the patient had contracted consumption from eating tuberculous meat, or drinking tuberculous milk?—I have had no experience whatever of patients contracting the disease from eating meat, and I have no definite evidence to offer in respect of milk. At the same time I cannot say that I have not suspected it.

1245. Have any cases occurred within your experience of healthy people, not apparently disposed to consumption, falling ill as a person would fall ill of scarlatina or diphtheria?—I have never heard of such a case.

1246. Do you think there is any risk of its occurring?—From eating meat or drinking milk?

1247. Yes——?—I can only take the evidence of other people. I have had no experience myself, but I should say there is a possibility.

1248. You would say that there is a possibility?—Yes.

1249. But you have no strong reason to believe that that is the way in which the disease is brought about?—No.

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1250. And what do you say in regard to milk?—I may say that I have had a strong suspicion in more than one case where the patient has become tuberculous.

1251. It is, of course, in children who are fed very largely on milk that you would expect to find these symptoms?—I have had cases which have occurred that I could not attempt to account for except on that assumption.

1252. Is it your practice in the hospital to advise the boiling of milk?—Yes.

1253. What is your opinion upon that matter?—I think that it is decidedly important.

1254. You are aware, I daresay, generally of the provisions which are contained in the Public Health Act and in the Dairies Act for looking after and inspecting the slaughter-houses and dairies?—Yes.

1255. And in Manchester the inspection is pretty regularly attended to?—I believe it is. I am not acquainted with the matter myself, but I understand that the inspection is regularly attended to even in the present state of the law. The duty devolves on the medical officer of health or the veterinary surgeon who inspects the cattle in the cowsheds.

1256. Of course everyone knows that the machinery of legislation is in its early stages, and may be greatly developed?—Yes.

1257. You are in favour of its development, I take it?—Yes.

1258. Even although you do not hold with the view, as far as your knowledge goes, that healthy people frequently contract consumption by eating tuberculous meat and drinking tuberculous milk?—Yes, certainly.

1259. Still, upon general grounds you would advocate the more stringent administration of the law?—Yes, and specially, because it is desirable that cows should be kept free from tuberculosis as far as possible. If that is to be effected it is necessary that they should be kept free from any source of infection.

1260. Do you found your general view as to the expediency of enforcing and making more stringent such laws as the existing sanitary regulations upon the view you entertain as to the risk mankind in general run of being poisoned by bacilli attacking them through the drinking of milk?—No, certainly not.

1261. Do I understand you to say that the nurses in your hospital have not shown any tendency to become tuberculous from waiting upon the patients?—No; certainly no such tendency has been shown.

1262. Do you attribute that to the course which is taken by the hospital authorities in keeping up a perfect ventilation?—Yes, mainly.

1263. Do you not think that that answer may be used as an admission by those who consider that consumption is decidedly of an infectious character?—Directly infectious, do you mean?

1264. Well, many people say so. If it is to be admitted that all consumption is contracted *ab extra*, then one may call consumption an infectious disease?—Yes.

1265. If so, would not the nurses in the hospital be the first to feel it?—Yes, if it were to come, like the whooping cough, with the breath they inhale. But my belief is that the bacilli come chiefly from the sputum, which is dried and carried off in fine dust, and which does not retain its life in fresh air and a dry soil. Consequently in the hospital it is not necessary that the nurses should take it, because, for one thing, we have the fresh air and the dry soil, and in addition we destroy the tuberculous sputa.

1266. Has that always been your practice?—Only within the last few years; since the discovery of Dr. Koch.

1267. Did you ever notice a case before?—No.

1268. Then if the bacillus is so easily got rid of, even in the hospital where it may be liable to infect the vessels and linen and so on, how do you make out that the disease is of this contagious character, and that people catch it from each other? What have you to give as evidence of that fact?—It has been proved that tuberculous sputa will convey the disease.

1269. Has it been proved that tuberculous sputa may be used as a means of infecting rabbits?—Yes.

1270. But that is not the point I want to know. I want to know how you reconcile your belief that consumption is infectious with the fact that there have been no striking cases in the hospital of nurses taking the infection?—Active tuberculous sputa has been powdered, and dogs have been made to inhale it, with the result that they have contracted tuberculosis simply from inhaling it.

1271. But before Dr. Koch's discovery of the bacillus, the nurses in the hospital were inhaling the air?—They were inhaling it in a hospital which was well ventilated.

1272. Ventilation, no doubt, would save them from risk to a great extent, but it is a strong thing to say that people contract this infection from each other in a particular part of the town or in a particular house, when they are absolutely free from infection in a well ventilated house, even although the virus must be constantly present?—I have formed an opinion that the bacillus actually gains in virulence after some little time under certain bad hygienic conditions.

1273. Would you not say that of all noxious germs which are now supposed to be to a great extent the means of giving disease?—Yes, I think so; like the germ of typhoid or the germ of cholera.

1274. You would feel disposed to include *tubercle-bacillus* in the same category?—Yes.

1275. I suppose that in the case of typhoid, it always undergoes some process in the sewer, or in the water-closet, or wherever it may be, before it becomes infectious?—That is the general belief now-a-days.

1276. And you think the same is probably the case with the bacillus of consumption?—Yes, mainly for the reasons which have just been stated.

1277. Would you go as far as to say that if in Manchester, for example, there is a house in a street which is full of consumption, the people living in it would contract it?—Yes, I would. I can pick out certain houses in the low districts of Manchester where the disease has occurred again and again, far too often to be accounted for upon the theory of probabilities.

1278. And too often to be accounted for by the unhealthy condition of the people?—Yes.

1279. Have you ascertained in some particular house that the people were born there, and suddenly seemed to contract the disease?—No, I have made no collective investigation of these records; but I believe that there have been cases of that kind. There are houses where the disease has been present for a good many years. In such houses, cases of consumption have occurred in succession.

1280. You do not hold, then, that the risk of catching the breath, as one calls it, of an infected patient, is a very dangerous thing?—No, I do not.

1281. But the emanations from an infected patient may pass through some stage and come back, and be very infectious indeed?—Yes.

1282. Apart from such means as I suggest, namely, a more stringent administration of the Sanitary Acts, is there anything else that occurs to you that would, properly made use of, tend to diminish the spread of consumption? Are there any other precautions that might be taken?—Yes. I presume that you mean more especially in reference to meat?

1283. Well, that is the particular subject of our enquiry?—Certainly I think that regulations with respect to the ventilation and drainage both of cattle sheds and of human dwellings ought to be put in force.

1284. Considering the immense extension of the area of consumption in this kingdom alone, can you fairly connect the existence of the disease with the condition of the dwellings in which the people live?—Yes, I think so.

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1285. Even among the higher classes of society?—Even among the higher classes of society. I believe they get it in attending crowded assemblies.

1286. I am afraid you will not be able to throw any light upon what is really the precise question with which we have to deal, namely, "to inquire and "report what is the effect, if any, of food derived "from tuberculous animals on human health; and, if "prejudicial, what are the circumstances and con-"ditions with regard to the tuberculosis in the animal "which produce that effect upon man"?—I think not.

1287. You would be an advocate for the stringency of supervision on general sanitary grounds?—Yes.

1288. But you cannot say that the risk to human beings is so serious from the consumption of meat and milk that you would attach undue importance to such sanitary regulations?—You say undue importance?

1289. I mean an exaggerated importance?—No.

1290. You do not believe, as a matter of fact, that I run any risk when I go to my butcher in Bond Street and order a joint of meat?—I do not. I should rather expect it in the low quarters of a town, such as Ancoats in Manchester.

1291. That is because sufficient attention is not paid to the condition of the animals when slaughtered?—Yes.

1292. (*Dr. Buchanan.*) Have you formed any opinion as to the proportion of tubercle that owes it origin to the consumption of infected meat or infected food of any kind?—I am afraid I have no direct evidence on which to form such an opinion. I should be inclined to believe it is a small amount.

1293. That the infection may be due to the ingestion of tuberculous meat?—I should think it was probable that a small amount might be due to that cause.

1294. Has there been any diminution in the prevalence of consumption in late years in Manchester?—I think Manchester has shared in the general reduction throughout the kingdom, but I have not had the figures placed before me as to the amount by which it has been reduced. I think, however, there certainly has been a reduction to some extent.

1295. You can only get at the mortality from consumption?—Yes; the statistics of the mortality are published.

1296. You will not be disposed to impute any improvement in that respect which may have been observable in Manchester to a better system of inspecting the slaughter houses?—No.

1297. Have you considered the propriety of excluding all meat from human consumption that is of a doubtful quality?—No.

1298. You have not, in your possession, any evidence that bears upon that point?—No; I doubt whether there is anything due to that cause, unless very recently.

1299. Until very recently?—Yes.

1300. We are told now that there is somewhat less, indeed, considerably less tubercle found in the Manchester slaughter-houses, and generally about the country?—That may be so.

1301. Owing to the care that is taken?—Possibly.

1302. (*Chairman.*) Do you know that it is so?—No, I do not know.

1303. (*Dr. Buchanan.*) Coming to your own hospital experience, what precautions do you take besides dealing with the sputa?—In the nature of disinfection or protection against the material of the communicable disease in the hospital?

1304. Yes?—None besides the destruction of the sputa and the thorough ventilation of the building.

1305. Nothing is applied to the clothing or bedding?—No.

1306. The clothing is washed in the hospital, and thoroughly boiled?—I must say that that is done.

1307. The clothing?—Yes, all the washing is done in the hospital.

1308. What do you do with the woollen things; are they also boiled?—No, I think not.

1309. The blankets and coats?—I do not think there is any special regulation with regard to that matter.

1310. What disinfectant do you use?—For the sputa?

1310*a*. Yes?—We use perchloride of mercury, and I have also used "Sanitas."

1311. You have no special object in boiling the milk in your hospital rather than boiling it anywhere else? I take it that the object is not special to the hospital?—Oh, no.

1312. Would you advocate the boiling of all milk before it is consumed, in order that anything of a diseased nature may be destroyed?—Yes.

1313. And not with special reference to the *tubercle bacilli* which may exist in your hospital?—No. I should advocate that the boiling of milk should be done; but I think it is of much less consequence in country places, such as that in which I live, than it is in towns where the cattle are likely to be affected by tuberculosis.

1314. What is the age of your nurses? Are you careful to select them of an age when they are less likely to fall ill from consumption?—No, we have had rather young persons as probationers. We have had them as young as 19.

1315. You are careful, of course, to choose them from people who have not a tuberculous history?—I cannot say that, because we have admitted some who have had tuberculosis. For instance, we have taken as a servant a person who had had the disease and had been cured in the hospital, after being cured she came as a servant in the hospital.

1316. What is your experience in regard to the liability of your nurses and attendants to be attacked?—They are not more liable than other persons to be attacked by the disease. There is one servant there now who has been there for some years.

1317. Was hers a *bonâ fide* case of tuberculosis when you took her?—Yes, and she has not recontracted the disease. Whereas, if a patient goes to his own home, he very often does recontract it. It is one of my strong injunctions to a consumptive patient that after he has been cured in the hospital he should change his residence, especially when he has been living in some of the low quarters of Manchester.

1318. Are second members of the same family apt to suffer under the disease?—Oh, yes.

1318*a*. Under the circumstances of the same household?—Yes, of the same household. In some of the instances I have mentioned in Ancoats, not only members of the same family, but of successive families coming into the house were infected with tuberculous disease.

1319. You are leading the Commission, I think, to judge that your view of the case is this, that whatever the influence of consuming tuberculous food and tuberculous meat may be in the production of tuberculosis, there are a number of other influences that are vastly more important factors in the production of tuberculosis in the community?—That is so in my opinion.

1320. (*Professor Brown.*) Speaking of the hereditary transmission of consumption, I rather gather that your belief is that in such cases the infective matter, whatever it may be, is transmitted to the fœtus in utero?—That may possibly be. I do not deny the possibility of it.

1321. If you say that consumption is hereditary in any way, what do you mean exactly by that?—I believe the more usual way in which it may be said to be hereditary is not by the transmission of the tubercle, and that persons are predisposed to receive it either by malformation or weakness of the lungs of certain kinds.

1322. That means that in order to get the disease the individual so predisposed must get the infective matter from without?—Yes; at the same time I do not deny the possibility of its being transmitted during conception; but I should think that the vast preponderance of cases is not of that kind.

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A. Ransom
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1323. Would your view as to the danger of eating infected meat lead you to condemn the carcase of an animal in which you knew that tuberculous disease existed in any part of it ?—I have not had much practical acquaintance with that part of the matter. I have had no direct experience upon it. I have not made special experiments in the way of inoculation, and I have no license to make inoculating experiments. Therefore, I have no direct evidence, and I can only trust to the evidence I have obtained from reading upon that point.

1324. But as far as your own view is concerned, you have no special idea on the subject ?—As far as my own experience goes, I certainly have none.

1325. Let me put the question in this way. If you knew that a joint of meat upon your table came from an animal in which tubercle had been found to exist, would you feel comfortable about eating it ?—Certainly not, if it were underdone.

1326. But you would not have the same objection to eating the outside which would be better done ?—No.

1327. (*Dr. Payne.*) You have told us, Dr. Ransome, that the bacillus which conveys the tuberculosis is almost universally distributed ?—Yes.

1328. Have you ever found it in dust, or in material of a similar nature yourself ? — I have examined the breath of a patient and found it.

1329. Am I to understand that you have not found it in the dust of the hospital, for instance ?—No, I have tried to find it in the air of the hospital, but I have failed. I have tried to collect it by condensing the air—the vapour of the air.

1330. Do you think it becomes more virulent after leaving the body ?—Yes, that is certainly the view I have formed, but I should not like to assert it positively.

1331. But still, no doubt you are well acquainted with the facts. I think you have mentioned them in your book relating to the ventilated part of the air in the Brompton Hospital ?—Yes.

1332. That, of course, was recent ?—Yes.

1333. And the air of the ward might be considered to contain the same material ?—Yes ; experiments were made with bad air which had already been partly exhausted. You could hardly call it good ventilation.

1334. You found the same material present there, although in a diluted form ?—Yes, quite recently we exposed tuberculous sputum in a shaft in our own hospital, and then inoculated a rabbit with it. It produced tubercle.

1335. Air from the hospital ?—Yes, similar sputum was exposed for the same time in a studio of my own which is well ventilated and well lighted, and it was absolutely disinfected.

1336. It had become quite harmless ?—Yes, quite harmless.

1337. Do you attribute the immunity from the disease of nurses and others in the hospital partly to their own good constitution ?—Yes, partly.

1338. (*Dr. Buchanan.*) You have published the results of these differential experiments, have you not ?—No, I have only just carried them out.

1339. They are of considerable importance ?—I have sent a paper to the Royal Society on the subject. I may mention that similar sputum exposed in one of the small cottages in Ancoats both in the light and in the dark, gave tubercle to rabbits. It was the same sputum, identically the same, as that which was exposed in my studio, and which did not give tubercle. It was exposed in the cottage in question in the window sill, and in some place near the bed, and means were taken to protect it from the possibility of infection from the inmates. After it had been exposed, rabbits were inoculated with it, and tubercle was produced.

1340. (*Dr. Payne.*) In a well ventilated place, it did not produce tubercle ?—No, it did not.

1341. You have no evidence to give us in regard to the danger of drinking tuberculous milk ?—No, I have no evidence as to that. But, if I may venture to say so, if tuberculous sputum is infectious in those badly ventilated places, and if dust from it is likely to get into the milk, there would possibly be danger.

1342. So that there might be infection from milk which does not come from tuberculous cows ?—Yes.

1343. I have only one other question to ask. You speak of the distribution of phthisis, geographical distribution of phthisis ?—Yes.

1344. Have you any evidence that its geographical distribution at all agrees with the frequency of tuberculosis in cattle ?—My attention has not been called to that point.

1345. Would it not be very difficult to prove ? I mean that tuberculosis in cattle is more frequent in towns than tuberculosis elsewhere ?—I suppose that in some countries tuberculosis in cattle is more prominent than in others. They make it out in Denmark that it has become more common, owing to the importation of English cattle.

1346. But you have had no experience of that ?—No ; there is one matter I may mention. It has been asserted that Jews do not get the disease, but I find that is not so. A large number of Jews have been treated for tuberculosis in our hospital.

1347. At the same time, you do not think that tuberculosis is acquired from the eating of food, in any large proportion of cases ?—No, I do not.

The witness withdrew.

Dr. James Frederick Goodhart, M.D., F.R.C.P., Physician to Guy's Hospital, and Consulting Physician to the Evelina Hospital for Children, was called in and examined.

Dr. J. F
Goodhart
M.D.,
F.R.C.P

1348. (*Chairman.*) Will you tell us the position you occupy in the medical world in London ?—I am physician to Guy's Hospital, and until lately I have been physician at the Evelina Hospital for Children.

1349. How long have you been at Guy's Hospital ?—I have been at Guy's for 13 years as physician or assistant physician, and I was demonstrator of morbid anatomy there several years before that.

1350. Were you previously at the children's hospital, or was it during the same time ?—During the same time.

1351. Has your experience with regard to consumption, whether in children or adults, been mostly at Guy's or at the children's hospital ?—Mostly at Guy's.

1352. Have you paid special attention to the subject at Guy's, during your career there ?—Yes, so far as it has come before me as a disease.

1353. Guy's is a general hospital, I believe ?—Yes ; but a large proportion of the cases which come in are consumptive cases.

1354. What proportion of the whole, speaking roughly ?—I really cannot say, but I should suppose that it is, perhaps, one-tenth of the whole.

1355. What is the whole number of patients ?—Some 4,000 odd pass through the hospital per annum.

1356. The hospital is always full, of course ?—Yes ; and there are out-patients as well.

1357. Are there a great number of consumptive patients who attend from outside ?—Yes, a good many of the out-patients are consumptive patients.

1358. What would be the number ?—I cannot say. There are about 50 deaths per annum in the hospital, taking it all round, from pulmonary consumption alone.

1358*a*. Are the consumptive patients kept in one ward ?—No, they are spread about.

1359. Have you any reason to think that consumption is infectious from one patient to another ?—No.

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1360. You are aware, of course, of the present state of opinion as to the communicability of consumption by means of the bacillus?—Yes.

1361. Do you accept, generally, the modern view upon that subject?—Well, my mind is still open upon the question. I think that recent evidence tends towards that view, but I am at present waiting for further information.

1362. For example, do you adhere to the view that tuberculosis is the same disease in animals as in mankind?—I think it is probable.

1363. You think it is probable?—Yes.

1364. Does it follow from that, in your judgment, that the disease in mankind originates frequently from the eating of meat which is the produce of tuberculous animals, or by the drinking of milk which is the produce of tuberculous cows?—I do not think that that necessarily follows. I think it is possible, but I do not think it is by any means certain.

1365. Have any circumstances occurred within your experience which point to that conclusion?—No.

1366. You cannot say whether, in the number of patients you have examined, the suspicion has arisen in your mind that so-and-so having no hereditary taint and no appearance of consumption has caught the disease as one may catch typhoid fever or cholera by some external application?—If the suggestion had not been made, I should say that nothing has come across me to make me think so.

1367. Even if we accept as authentic and proved the experiments which have been conducted between animal and animal by way of inoculation, would that, so far as it goes, induce you to believe that the infection of mankind from animals through breathing, eating, or drinking, was of frequent occurrence?—No, I do not think it would lead me to suppose that it was. I think there are other possible ways in which it may be produced.

1368. Do you think it has ever been developed from an hereditary tendency without the poisoning which might be occasioned by the bacillus, or some such means as that?—I should think that that is possible, but doubtful. I think that hereditary predisposition in rendering a person susceptible is a strong point, but I think that something else is needed.

1369. However, in your own experience as a physician in the two important places you have mentioned, you have seen nothing that strongly illustrates the danger of contracting disease in England, for example, by the loose and careless manner in which meat and milk are consumed?—I have seen nothing.

1370. Do you advocate, as a matter of precaution, the advisability of boiling milk for children?—Yes, but not especially as regards tuberculosis. I should advocate it on other grounds, namely, to prevent infection from typhoid fever, and so on.

1371. Then I am to understand that you are prepared to accept the communicability of tuberculosis, and to place it in the same category as the communicability of typhoid fever, through the agency of milk?—I do not go so far as that at present, but I invariably advocate the boiling of milk independently of the risk of tuberculosis said to attach to it.

1372. You say, in regard to risk, that milk is the more risky of the two?—From what I know personally, I should say nothing, but from what I have read, I should say that it is the more risky of the two.

1373. You would be in favour, I suppose, generally speaking, of anything that would strengthen the sanitary laws we have in this country, and increase their stringency, and make them of more universal application?—Certainly, speaking generally of the sanitary regulations. But not with any special view to reducing, by that means, the quantity of consumption which we know to exist in the country?—I should hope that that might be so, but I should take no special precautions to that end.

1374. You would be inclined to attribute an improvement to the general conditions rather than to the removal of specific causes of disease?—So far as I know at present, yes.

1375. (*Dr. Buchanan.*) I see in the memorandum which you have been good enough to write for the Commission, that you have some experiences and opinions to offer us in regard to the probable place of entry of the tuberculous material into the body. It is of considerable importance to our Commission to form, if we can, some sort of judgment as to the way by which tuberculous matter infects the body. Will you be good enough to tell us what your views or experiences are on this subject?—Well, the point that I am inclined to make a good deal of is the fact that at any rate the disease in children is not unfrequently a general one of the glands. If, therefore, the disease is due to a bacillus, it does not apparently stop at the seat of inoculation, but makes its way first of all to, and produces the disease in, the gland itself.

1376. That seems to leave it an open question how far a general predisposition on the part of the patient may not be at least as important as the bacillus itself?—It seems to me that that is a fair mode of argument, and in the memorandum I have handed in I have pointed out, although it is not a conclusive point at all, that if the consumptive condition is due to inoculation, one would expect it to show some of its earliest features in the earliest part in which the inoculation took place. In the case of children, the intestinal canal, I think, fails to show that fact, while the condition is general in the glands inside the body, the disease is not in any way particularly and specially developed in the intestines.

1377. It is not in any way particular or special to the intestinal glands?—In regard to that, even although it may not be considered an argument, it is a point which carries much weight with us. It seems to me that the changes we find in the glands themselves are changes one might predicate as being likely to occur. The cheesy changes which take place at the same time appear to be part of the pathological process one would expect to find, whether bacilli were present or not.

1378. We have been told, I think, that the presence of bacilli is necessarily coexistent with the existence of caseous tubercle. Do you hold that view?—Yes, in regard to caseous tubercle; but before we can call it tubercle, I wish to say that there are many caseous changes in which you find no bacilli. Therefore, I am not prepared to admit that the bacillus is a necessary constituent of caseous glands, although it is often found there. I think there are reasons for believing that a caseous condition of the glands subsequently leads to the development of bacilli. It forms a favourable nidus, so to speak. That view is borne out to a certain extent by the condition of the miliary tubercle. We cannot say that bacilli may not be there, but one has looked for them and not found them. If I want to find bacilli in numbers, I must go to the walls of cavities and the parts which are already caseous and softened down.

1379. You would not say that an antecedent condition is required for the deposit of the tubercle bacillus?—Well, I am inclined to consider that there is an antecedent condition necessary in order to enable it to cultivate and take hold.

1380. (*Chairman.*) From what we hear, consumption is less frequent than what it was?—I could not answer either way.

1381. (*Dr. Buchanan.*) Do you regard the bacillus as being, as it were, omnipresent in the atmosphere of an ordinary street and of an ordinary room?—I should suppose that it must be very widely spread. I think there is some evidence of that in the early experiments which were made by Villemin, Wilson Fox, and others, who produced tuberculosis by making a cut and putting all sorts of things under the skin. A good many experiments have been made in the shape of inoculation by tuberculous matter, and there is no doubt that now tuberculosis has been thus produced in the lymphatic glands; but more recent and carefully conducted experiments have proved that tuberculosis is only produced by tubercular element.

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If that be so, I think it almost follows from the older experiments, seeing that a tuberculous condition can be produced by simple wounds, if only the minutest precautions be neglected, that the tuberculous germs are very widely distributed. The fact could only be accounted for otherwise on the supposition that all the instruments used in making the experiments were dirty, which I think is very unlikely. It seems to me that tuberculous matter sufficient to enable a person to take the disease is very widely spread, or else is largely dependent for a footing upon individual proclivity.

1382. As regards the introduction of tuberculous matter by means of the intestinal canal, can you tell us anything of the influence of the gastric juice in the intestinal secretions, its influence, if any, upon the substance of the tubercle bacillus?—I know nothing of my own knowledge. I know practically nothing except what I have read.

1383. Does one form of bacillus differ from another form in this respect?—Yes.

1384. As regards the anatomy of the disease in adults and children, can you give us the result of any observations you have made on that subject as to the differences in the one case and the other as indicating the presence of a tuberculous condition?—As regards the intestines there is no doubt this very marked difference, that in adults a simple tubercular ulceration of the intestines is quite common without any glandular tuberculous condition, whereas in the case of children it is very uncommon. That is one of the great differences between tuberculosis in adults and children, and there is also another difference. Adults get a particular kind of phthisis, beginning at the apex of the lungs and spreading down, whereas children get a different kind, which is obviously due to the cheesy disease of the glands.

1385. What would you hold the relation to be between a disease affecting the mucous membrane of the lung and a disease in the mediastinal glands?—I should regard the pulmonary change as a direct extension from the mediastinal glands, the neighbouring tissue having been subsequently infected by that direct extension. It may sometimes occur by material getting into the blood vessels and being distributed.

1386. You would make a distinction between the mediastinal glands and the phenomena you observe in the mucous membranes?—Yes.

1387. You arrive at that conclusion from the history of the cases which often occur from whooping cough or bronchial pneumonia?—Yes.

1388. It is an indication?—Yes.

1389. Is it a common thing, in your experience, that after having had the whooping cough you find children become tuberculous, without being connected with any family history of tubercle?—Yes, that is quite common. I think I may say that a certain number of cases occur without any family history, although there can be no question that cases having a distinct family history are very widely spread.

1390. You get a very acute form of tuberculosis under these circumstances, I believe?—Yes.

1391. And you can tell us of other diseases which have the same tendency to be accompanied by tuberculosis?—Yes.

1392. Such as measles?—Yes, measles and whooping cough are the chief, because measles and whooping cough are practically diseases of the bronchial tubes. But the abdominal forms of the disease would be set up by the intestinal catarrh.

1393. And in that case, in the case of measles and bronchial pneumonia and whooping cough, how do you suppose the requisite bacilli find access to the body. Do they invade the mucous membrane?—I should suppose that they do. There is reason to believe that they are in all of us, and only want a good cultivating soil to permit of their development. I should suppose that they do not effect a lodgment in certain people. I think they are present in all of us, but we manage to strangle them.

1394. Am I to take it that you and I are breathing tubercle bacilli at the present moment?—I think it probable that we do so in the course of a day, certainly I must do so in the hospital and in the frequent examination of the consumptive.

1395. I see you have a note here of another form of tuberculosis in children that is not so common in adults, namely, the formation of large masses of tuberculous disease in the omentum. Is that anything more than the existence of tubercle in the glands you are speaking of?—I think it is special in its beginning. In later stages it is bound up with mesenteric disease, but for some reason or other among children large masses of tubercular disease form in the omentum and certain other parts of the peritoneal system which on the whole seem to avoid at first the mesenteric glands.

1396. Do the mesenteric glands become infected with bacilli as a secondary stage?—Yes, I think so. In the case of the formation of tuberculous matter in the omentum it becomes converted into a mass of caseous material.

1397. In that case is it often precedent to the caseation, and in the case of tonsillar inflammations would you take the same view of the caseous nature of the tuberculous disease preceding?—I should take it that the unhealthy condition of the mucous membrane leads to caseation of the neighbouring tributary glands, and the tuberculous condition becomes engrafted upon that.

1398. Is it a general proposition that in cases of chronic lesions of a tuberculous nature the tuberculosis consisted primarily of the change in the glands resulting in caseation?—Yes.

1399. And the infiltration of this matter by the tubercle bacillus is the foundation afterwards of tuberculosis?—Yes.

1400–401. And how about the more acute disease in children—the mediastinal tuberculosis, for instance?—The explanation I should give is, that a primary cheesy focus is present in some particular place, and that by some accidental circumstance a vessel is opened, the material is then carried about and acute miliary tuberculosis is set up.

1402. We are very concerned to have your view shortly in regard to this matter, and if you will allow me, I propose to read the passage in your notes that is before me, and then to ask you if it exactly represents your judgment on the subject. You say here, "I should hold, therefore, that in childhood the "disease of the glands is in many cases a non-"tubercular one to start with, and is due to catarrhal "or inflammatory conditions, and these, no doubt, "are favoured or perpetuated by hereditary proclivi-"ties and by faulty hygienic conditions of all kinds. "In adults similar favouring influences are at work. "Tuberculosis of the lungs starts at first and spreads "along those parts that are most feeble in their "movements and earlier and most affected by "emphysema; and it spreads by the carriage of "infective material there generated along the main "bronchi"?—Yes, that is my view.

1403. You go somewhat further in what you have told us to-day than what I have read from this passage. But I take it you would still tell us that it requires the antecedent condition of the kind you have described here before the tubercle bacillus could take effect?—Yes, I think so; that is my opinion.

1404. (*Prof. Brown.*) From what you have told us of your practice at your hospital, it seems that you have not been much impressed with the danger of the transmission of the disease from man to man?—No.

1404*a*. They do not take any special precautions in the hospital?—No.

1405. Are there any precautions at all taken in regard to consumptive patients?—No, I think not.

1406. You do not insist on the milk being boiled?—No.

1407. Nor on the perfect and sufficient cooking of the meat?—Well, I do not think that that is

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insisted upon in reference to the tubercular conditions. It may, however, be insisted upon, because the patients like it.

1408. But not on the particular account I have indicated?—No.

1409. You do not give the patients raw meat, as we have been told to-day is the practice in Manchester?—No.

(*Dr. Payne.*) Not in Manchester, I think, but in Berlin.

1410. (*Prof. Brown.*) I thought the witness said Manchester. (*To witness.*) You do not use raw meat?—We give the patients raw meat for special purposes.

1411. Are you aware when a patient is fed on raw meat that it has been examined for the purpose of ascertaining whether it contained tubercle bacilli?—No, I do not think it undergoes more than a general examination by the cook or some other servant of the hospital.

1412. I think we may understand that if the authorities in the hospital generally were at all impressed with the risk of eating infected meat or drinking tuberculous milk they would naturally take all these precautions?—One would think so, certainly; but I do not know whether up to the present time, the matter has really been pointedly before the hospital authorities, I do not mean to say that if it were represented that that is the modern doctrine they might not adopt precautions of this kind.

1413. If, for instance, the Commission were to report that they are satisfied from the evidence that there is a great risk from eating uncooked meat and drinking unboiled milk, they might possibly be induced to adopt these precautions?—I have no doubt.

1414. (*Dr. Payne.*) I understand you to say, in your opinion, a mesenteric disease in children in connexion with caseous glands, is in the beginning a non-tubercular disease?—Yes, I think so.

1415. And that in many cases there are no bacilli to be found?—No, I do not wish that to go down. I do not say that many caseous glands do not contain bacilli, but my opinion is that they do not necessarily contain bacilli. A caseous gland seems to me part of the natural process of degeneration in inflammatory conditions of the glands. You may find them without bacilli, but I do not think you will find many without.

1415a. You do not say that from your own observation you have found many without?—No.

1416. Supposing there is a non-tubercular disease of this kind, do you think it would be a fatal disease?—I should think that all general conditions of the glands such as that would constitute a fatal disease.

1417. Do you find that children die of diseases of that kind where there are no tubercles?—No, I think you may find that that is the case occasionally, but not often, but a general condition of caseous glands may certainly exist in which you find no tubercles.

1418. No tubercles proper?—No.

1419. And you think that the chance of getting tubercle from the milk of cattle is a risk worth guarding against?—Yes, I should certainly say yes.

1420. You would not like, for instance, to drink milk from a cow which was suffering from a tuberculous disease?—I should not trouble if it were boiled.

1421. Have you any positive knowledge of the effect of boiling?—No, I only say so.

1422. Tubercle in the muscles is exceedingly rare, I believe?—So it is said.

1423. You have never seen it?—No.

1424. Then the absence of tubercles in the muscles of meat would be no proof that the animal which furnished the meat had not a tuberculous disease?—No.

1425. It might indeed have had a very general tuberculous disease?—Yes.

1426. And yet the meat would be consumable?—Yes.

1427. I mention that, not that there is any doubt about it, but because I want to have it from you?—I quite understand.

1428. Are you acquainted with any fact or means by which you can detect tubercular infection in meat except that there are tubercles there?—No.

1429. Have you ever examined for tubercle bacilli in milk?—No, never.

The witness withdrew.

Inquiry adjourned until Wednesday, December 10th.

ELEVENTH MEETING.

7, Whitehall Place, S.W., Wednesday, December 10th, 1890.

PRESENT:

THE RIGHT HON. THE LORD BASING presiding.

Professor G. T. BROWN, C.B.
Dr. G. BUCHANAN, F.R.S.
Dr. J. F. PAYNE.
Professor J. B. SANDERSON, F.R.S.

Mr. LEOPOLD HUDSON, *Secretary.*

Dr. H. D. Littlejohn, M.D., F.R.C.S.

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Dr. HENRY DUNCAN LITTLEJOHN, M.D., F.R.C.S., Medical Officer of Health for Edinburgh and Consulting Medical Officer to the Local Government Board for Scotland (Board of Supervision) called in and examined.

1430. (*Chairman.*) I believe, Dr. Littlejohn, that you are the Medical Officer of Health for Edinburgh?—I am.

1431. And you hold some position which connects you with the condition of health in Scotland generally?—Yes, I am Consulting Medical Officer to the Local Government Board.

1432. You were a member, I believe, of the Departmental Commission on Tuberculosis?—No; I only gave evidence before it.

1433. We have that evidence in our box. May I ask you, without going over it at length, to state shortly what that evidence amounted to?—If I were to summarise it I think I should say that it dealt with the difficulty which had been experienced both in England and Scotland generally in coping with the question of tuberculosis, in consequence of the disease not being specified in the Contagious Diseases Animals Act; I gave the committee all the information in my power on that subject.

1434. Dr. Buchanan reminds me that of course tuberculosis in not specified either in the Public Health Act or in the Contagious Diseases Act?—That is so.

1435. Therefore, on the one hand it is not in itself a criterion of the unwholesomeness established by law, and on the other it is not a subject in regard to which

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public compensation is to be granted. Those are your points, I think?—Yes, those are my points. The next thing I attended to was giving a sketch of how we dealt with tuberculous disease in animals in Edinburgh.

1436. I propose to ask you some questions upon that point presently. Was there any other subject to which your evidence had special relation?—Yes, lastly, there was the question of compensation.

1437. We are not here on the subject of compensation at all. Our great object is to ascertain whether the eating of meat of tuberculous animals by mankind is or is not injurious to health. Can you give us any information upon that point?—That is what I understand the object of your inquiry to be, but you asked me to summarise the evidence I gave before the departmental committee.

1438. What I want principally of your evidence is anything which in your experience as a medical officer of health tends to show the difficulty of dealing with tuberculosis, and how to prevent it from being communicated from animal to man?—Just so; but I am afraid that I have no evidence to give the Commission as to the communication of the disease to a human being.

1439. In consequence of the ingestion of tuberculous meat?—No; none whatever.

1440. And your difficulty originates in this, that you felt bound, by your conception of your duty, to condemn meat as unfit for consumption which was not so characterised either in the Public Health Act on the one side or in the Contagious Diseases Act on the other?—Yes; that is my opinion.

1441. You felt it your duty to condemn it as unfit for human consumption on the ground that it was, in your opinion, injurious to health?—Yes.

1442. When you say it was injurious to health, do you mean to go further than to submit that the meat which you felt it your duty to condemn was obviously, and to the eye of all men, unfit for consumption, or in a state that apparently rendered it unfit for human consumption; because, I take it, that under the Public Health Act you are not to define what is the reason which induces you to arrive at the conclusion that it is unfit for food, except its obvious inapplicability for food?—Yes.

1443. Was it the case that when you came to condemn the tuberculous meat, you did it not from anything that appeared in the condition of the flesh, which an ordinary person would have detected at once, but because a microscopic investigation would show that it had tuberculosis in it?—I can only answer that question by saying that our experience has been going on enlarging day by day. The time was, some 12 years ago, when we passed carcases in which tubercle was manifest, but now we consider it advisable to condemn all carcases which show a certain condition of infection in the glands. When we find that the glands are infected, even where the flesh has a marketable look, we condemn the animal.

1444. Now, may I ask on what ground you do that?—We do it in general upon what are called pathological grounds. We know what the glandular system means, and we believe that when the glands are infected the whole lymphatic system which pervades the body must be more or less infected. If the udder of the cow, for instance, is infected, and the secretions which it contains, it will be found that the whole system is infected. It is our common experience to find in such a case that the mesenteric glands and the mediastinal glands are infected. We often find that those glands are infected, although the flesh appears to be good and marketable; and in the interests of the public we condemn the entire animal.

1445. What is your knowledge and experience which induces you so to condemn it?—I may say that, first of all, there is a medical consensus of opinion that when the glands of an animal are infected the entire animal must be infected as well.

1446. Whether by tuberculosis or anything else?—Yes; by tuberculosis or cancer, for instance; and in the second place, our common sense induces us to condemn the animal. It would be altogether improper, in my opinion, to allow the flesh of a diseased animal to pass into consumption, however apparently good it might be at a superficial glance. It would be wrong to allow it to be sold for human consumption without a hint to the purchaser that the meat in question had come from an animal that was diseased; I say that that is a question of common sense.

1447. But, common sense or not, it is not in the Public Health Acts, or in either of them?—No.

1448. And, to a certain extent, you put a gloss upon those Acts which your knowledge and experience teaches you to be right, and which, according to your own conscience, ought to be acted upon?—That is so.

1449. The difficulty arises from your having no legislative authority to back you up in pursuing such a course?—Yes, that is so.

1450. Has the difficulty to which you allude grown upon you since the experiments upon animals have been conducted, and since the bacillus has been discovered?—Yes.

1451. Those experiments and the discovery of the bacillus have aroused the idea of the identity of the disease between animals and man, or was the idea anterior to that date?—It has chiefly been entertained since Dr. Koch's great discovery.

1452. Then, if it had not been for that discovery, you would not have felt that it fell within your statutory duties, as it were, and gentlemen in your position would not have condemned apparently good and useful flesh by going back to the carcase and finding tubercles in parts of the animal that might never have been intended for food?—No; and I may add that all inspectors and sanitary officers have received an enormous encouragement and impetus in the discharge of their duties from the discoveries which have been made within the last five or six years.

1453. Let me put a question to you of a somewhat different character. Has the irritation and excitement which have been produced by the action of the medical officers in Scotland among the butchers and dealers grown from the feeling they have entertained, that they ought not to be held responsible for a condition of the flesh which would not have been held in former days to render the meat unsaleable?—It has to some extent, and with some show of reason, I think, because they get no compensation.

1454. Suppose it is held that no compensation is needed, because no part of the flesh is otherwise than unfit for human food?—My answer to that is again the question of common sense. We see an animal infected with disease; how are we to allow the flesh of that animal to be exposed for sale without giving the slightest hint to the purchaser that it is unfit for food? I would even go so far as this: some of these days we shall find it necessary to have two kinds of shops; in the one shop you would have a guarantee that the flesh was of prime quality without the slightest suspicion of disease, while in the other, or second-class shop, there would be a certificate to the effect that the meat came from an animal which had been suffering from disease, but not to a very large extent, so that the inspectors and sanitary authorities were justified in allowing it to be sold. It would then be bought or not, just as the public thought proper. It would not, however, be presented to the purchaser as meat that was free from all taint of disease.

1455. But if it could be made out that apparently healthy flesh contained *tubercle bacilli*, although it seemed to be sound, would you allow it to be consumed under such circumstances?—Perhaps so. At any rate there would be no other alternative pending the result of the inquiry of this Commission. But, if the issue of this Commission is that such meat is poisonous, then most certainly I should be prepared to obey the conclusion at which the Commission arrived.

1456. To come to that point, which is a very important one, have you any evidence to show, or can

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you state to the Commission upon your own authority and experience, that the flesh of an animal has ever conveyed tuberculosis from an animal to man?—No, I have no such evidence to offer.

1457. You are not acquainted with such a case?—No, it has never been proved. At the same time, it has never been proved in the case of pleuro-pneumonia, yet we condemn pleuro-pneumonia, and order all cattle suffering from it to be killed. Here again it is simply a question of common sense. If I were offered from the first butcher in the town a roast of meat, and he said, "I am bound to tell you that one " or two of the glands were infected with tuberculosis " at the time the animal was killed," I would not take it. Yet, in offering for sale parts of an animal roasted, the pieces showing infection having been cut out, I would defy anyone to make out anything in the parts that were offered for sale, so as to justify a court of law in taking action, and declaring that the evidence was sufficient to show that the meat could not be used without risk.

1458. But would it not be necessary to show that the consumption of such meat would have an effect injurious to health and might result in the planting of a mortal disease in the consumer?—What do you say about pleuro-pneumonia?—Pleuro-pneumonia does not infect the individual who eats the meat, and yet we condemn and order the slaughter of the animal which has the disease under the provisions of the Contagious Diseases (Animals) Act. I could mention a case in which an inspector allowed meat to pass, but strictly prevented it from being made use of at his own table.

1459. Whatever may be the facts of the case so far as pleuro-pneumonia is concerned, parliament has laid down certain rules in regard to that case which, so long as they remain law, must be obeyed, whether we may believe them to be necessary or not?—Just so.

1460. But it does not follow that because Parliament has acted in that manner in one case it may act in the same way in another. It may or it may not, but what we want to find out is whether there would be any justification for imposing the same regulations and restrictions in the case of tuberculosis. I understand that part of your complaint in regard to tuberculous meat is that it may infect a family which is induced to consume it?—I have been in Edinburgh for the last 40 years, and no case has ever been brought under my notice in which I have been able to trace a connexion between diseased meat and tuberculosis in a human being. I have never seen, any bad results as the direct consequence of ingestion, of meat, except in the form of pies, which is capable of explanation on purely chemical grounds.

1461. You have not known of such a case?—No, I have never known of a single instance. No person has ever come to me and made such a complaint, either in regard to himself or his family, or said that they had been suffering from tuberculosis in consequence of the ingestion of meat from the carcase of an animal which must have died with the disease largely developed in its carcase. It is a fact that it would be exceedingly difficult to prove.

1462. Let me ask you a word as to your conviction. Roughly interpreting what you have just said, I take you to mean that tuberculosis has never been imparted to mankind by the consumption of meat which came from an animal of an apparently wholesome character?—You say from an animal which was of an apparently wholesome character?

1463. Yes?—Well, I cannot shut my eyes to the general prevalence of tuberculous disease in young children especially, and the enormous amount of this tuberculous meat which is being sold, and also the large amount of tuberculous milk which is sold in such towns as Edinburgh, and which comes from notoriously tuberculous cows. In proof of that assertion, perhaps you will allow me to refer to the operations which have taken place in Edinburgh since the recent stringent orders were issued in regard to pleuro-pneumonia. Those operations in Edinburgh have had the effect of opening our eyes. We have cleared out the cow houses, containing a large number of animals which were giving milk to the people of Edinburgh, and what have we found? I have taken a selection of 13 cow houses which have been cleared out under the recent order passed in September. It began to be acted upon on the 9th of September, and what has been the result in the case of these 13 cow houses? Not less than 300 cows were slaughtered, because one among them exhibited evidence of the existence of pleuro-pneumonia. No other cow had the disease. It was found that 64 out of the 300 were quite healthy but 120 were suffering from tuberculosis. They were, however, supplying the city with milk in large quantities, yet no one would have suspected from the look of the cows that they were infected with tuberculosis. I found that among the 300 cows the per-centage of those which were diseased varied in the different cow houses from 12 per cent. to 83 per cent., now, in regard to the case where the per-centage amounted to 83, I know very well what the conditions of that cow house were. The keeper to whom it belonged had neglected to provide sufficient ventilation. I watched with some interest the animals which were taken from that cow-house and there was scarcely a satisfactory case among the whole of them. Then again there was the case of a man with 13 cows. It was among his stock that pleuro-pneumonia appeared. One of the cows was slaughtered on account of that disease and this was followed by the slaughter of all the rest, because the recent order requires all the herd to be slaughtered whenever pleuro-pneumonia makes its appearance in any one of them; only two were found to be healthy. All the rest of the animals were found to be infected with tuberculosis and were giving milk to the inhabitants of Edinburgh. As I have often said, that was a much more serious matter to Edinburgh than it might be to many other large towns, because it is a great centre for our educational institutions, and contains a very large juvenile population. In No. 2, the glands and the lungs were infected with *tubercle-bacilli*, and the cow was condemned although the meat appeared to be good. In No. 3 the cow was generally tuberculous and condemned.

1464. But the cows were not condemned to be slaughtered on that account?—No, but the meat was condemned.

1465. Condemned under the regulation which applies to animals suffering from pleuro-pneumonia?—Yes; I was proceeding to explain what we discovered to be the condition of the cows which were slaughtered in Edinburgh under the recent order. In the next case the animals were found to be suffering from general tuberculosis; the next was general tuberculosis also; in the next case the lungs only were found to be infected; in the next there was general tuberculosis; the next case was general tuberculosis also; and the last was the case of a cow which I am sorry to say, was allowed to go into consumption. The cow had a slight trace of infection in the mediastinal glands and the glands of the thorax. In that instance the meat, very improperly I think, was allowed to go into consumption, and I should like to know from this Commission what ought to be the course pursued in a case like that, where there was apparently only a slight chance of infection being conveyed from the cow. I may add that all these people, the owners of the cows which were slaughtered, got compensation under the new order. Before the issue of the order they would not have received compensation.

1466. Under the Contagious Diseases (Animals) Act?—Yes.

1467. Allow me to remind you that the order is founded on the desirability of condemning and slaughtering animals with a view of preventing the spread of cattle disease?—Up to the month of September there was no compensation paid, but the magistrates of Edinburgh, chiefly on my recommenda-

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tion granted limited compensation on the representation of the butcher that the animal was tuberculous. He would arrive at that conclusion from the state of emaciation in which the cow appeared. In a case of that kind the magistrates agreed to grant a limited compensation to the extent of about one-half of the value. This was done by the magistrates of Edinburgh in order to soothe the butcher and prevent him from feeling a sense of injury.

1468. Then are we to take it that there is a small epidemic, so to speak, of tuberculosis among the cows in Edinburgh?—No, I do not say that, but I wish to point out to the Commission that there has been a remarkable increase in the number of tuberculous carcases which have been found infected and condemned. For example, in the year 1887 only 14 per cent. of all the carcases condemned as unfit for human food were found to be tuberculous; in 1888 the percentage increased to 32; in 1889 it was 29 per cent.; but this year, 1890, it has mounted up, chiefly owing to the putting in force of the order, to 39 per cent. of all the carcases destroyed.

1469. Then do you argue that the condition of the cows in Edinburgh in regard to tuberculosis is worse than that of animals in other great towns?—No, I think not.

1470. Do you attribute their unwholesome condition to the circumstances in which they are kept?—The condition of the cow-houses in Edinburgh and in the country generally is simply disgraceful. The cowshed order is certainly not administered as it ought to be.

1471. I have heard—I do not know whether it is the case now—that the milk supply in Edinburgh is for the most part furnished by cows which are fed upon Craigintinny meadow grass, is that so?—Yes, it is quite correct.

1472. It is so still?—Yes.

1473. Do you attribute any ill effects to it?—No, I do not. We have a notion in Edinburgh that this grass is very succulent.

1474. I have been given to understand that the Craigintinny meadows are flooded with the sewage of the town?—Yes, they are.

1475. Do you attribute any injurious influence to that fact?—No, I do not.

1476. Then if there is any epidemic of tuberculosis among the cows in Edinburgh, I understand that you attribute it to the condition of the houses in which they are kept?—Yes; but there is one other fact. We discover the existence of the infection more readily now than formerly in consequence of the care we take in the examination of the carcases. Hundreds of carcases are condemned now which would have been allowed to pass into consumption 10 or 12 years ago.

1477. You have already said that you cannot point to any cases of the communication of consumption from animals to mankind from your own knowledge and experience?—No, I am unable to do that.

1478. But is it your belief, from your survey of the case, that if tuberculous animals are effectually prevented from being brought into consumption at all, there would be an immediate, although probably a a gradual, diminution of the amount of consumption in the kingdom?—Yes, I have no doubt of it.

1479. Do you hold with the witnesses we have had here before that consumption is not bred in the system of the patient, but comes upon a patient, who is more or less qualified to receive it, from without; and is either imbibed or ingested or inhaled just as the infection of typhoid fever may be?—Yes, I agree with that opinion.

1480. You agree with it?—I do.

1481. Nothing can be stronger than the statement you have made, that it is impossible to prove by actual experiment that the use of tuberculous meat does convey a fatal disease to mankind?—I suggested to the former Commission that we might be placed in a position to try experiments upon criminals, and make a careful examination of their bodies.

1482. (*Dr. Buchanan.*) It would be necessary to try the experiments upon a good many?—We could commence with one.

1483. (*Chairman.*) Although a great suspicion of danger is naturally aroused in one's mind by being told of the armies of *bacilli* which are in the air, and all that; although that is so, it cannot be said that consumption is an infectious disease in the ordinary sense of the word?—I have never seen any cause to support that view; but I have had my suspicions. I have seen, for example, a police constable suffering from consumption. He ultimately died among his own family. After his death two or three members of the family suffered from consumption, but of course it is exceedingly difficult to prove a connexion between any two cases. All I can say is, that I have had my suspicions, those suspicions are shared by other people, and among the lower class of people they are so strong that they will not allow anyone to sleep with a consumptive patient. Personally I have been exceedingly pleased to see the care which is exercised in that way.

1484. How do you reconcile the frightful liability to become infected with that which must be the real cause of infection, if all we hear is true?—How do you reconcile the frightful risk which is run from the universal spread of the bacilli with the difficulty of ascertaining by experiment or observation that so-and-so has caught consumption from so-and-so?—There are other elements which must be determined before that question could be answered. Take, for instance, the case of a cow.

1485. I am speaking now of the spread of infection between man and man?—Then look, for example, at the great want of care which is displayed in the houses of the people. Expectoration or sputum is a fruitful source of conveying the infection, and yet very little care is exercised as to what is done with the expectoration. Persons are frequently seen to expectorate on the floor.

1486. My question was rather in the opposite direction. How is it, if the conditions and liabilities are so rife, and so universally spread about us, how is it so difficult to prove that consumption has not been contracted from one person to another? You say it is very rarely the case that you can ascertain that fact. Do you not think it would be of universal and constant occurrence if the modern theory about tubercle is not to be accepted without some limitation?—Luckily for many of us our constitutions enable us to resist the bacilli. If it were not so, they would clear off the human race. *Tubercle-bacilli* must be floating about everywhere; in the air and in our houses. I consider that they are present in this room at this moment.

1487. In the same way that scarlatina is always among us and about us?—Yes. I should say that Edinburgh is never free from scarlet fever, and the same may be said of London. We are free from it in an epidemic form, but I have no doubt that there are the germs of the infection in the air. Why they should be more powerful at certain times, and exercise a stronger influence upon our health, we cannot tell. In the same way I have no doubt that the *tubercle-bacilli* are flying about the air.

1488. But all the more so when the effect is epidemic, as we call it, than when it is not?—Yes.

1489. Thank you, Dr. Littlejohn, you have given your evidence very fairly and very concisely. I have endeavoured to do so.

1490. (*Dr. Buchanan.*) Will you tell us something more about the Edinburgh abattoirs? What quantity of beef reaches your abattoirs in the state of live meat as compared with the quantity which comes in as dead meat?—We do not receive any dead meat.

1491. Not in your abattoirs?—No.

1492. Where does the dead meat go?—The dead meat question is one of the difficulties we have to contend with in Edinburgh. The dead meat is brought into the city from the country, but it is not taken to the slaughter-houses. The magistrates of Edinburgh have

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determined that it shall not be received in the slaughter-houses.

1493. Where is it inspected then ?—It is inspected at certain dead meat depôts belonging to private individuals, but the corporation of Edinburgh are promoting a Bill in Parliament this session to enable them to have a clearing-house, so to speak, for all the dead meat that is brought into the town. When that is done, the inspectors will be at once able to stop *in limine* the entrance of diseased meat into the town.

1494. Then that is not done at present ?—No.

1495. Does bad meat find its way into Edinburgh ?—I am afraid that it does. For instance, a basket of meat arrives by railway for the butchers. At present there is nothing to hinder that meat from being conveyed to the butcher, who cuts it up into pieces, and exposes it for sale. If it presents no unusual appearance it passes at once into human consumption, and Edinburgh, like most other large towns, becomes a sink and cesspool for diseased meat. The corporation are promoting a Bill to compel all the meat which now comes in *ab extra* to be conveyed to a clearing-house, and not distributed to the butchers until such time as it shall have been examined by a skilled inspector, and an opinion expressed in regard to its soundness, and the freedom from disease of the animal from which it was taken.

1496. Do you propose to take care that the inspectors see the organs of the animal as well as the flesh ?—Undoubtedly. The establishment of this clearing house will give the authorities of Edinburgh a hold over the trade of the country. All the meat which is sent in would have to pass through a certain routine or the local government inspector would not give a certificate. The legislature of this country has decided that local veterinary inspectors should be appointed to discharge the duty of inspection, and whenever the slightest suspicion is aroused as to the soundness of the meat, there is power to call in the local veterinary inspector.

1497. In that way you would exercise a control over the dead meat trade as well as over the live animals ?—We hope that we shall be able to do so.

1498. Do you think that you will be able to discharge that duty efficiently ?—Yes, I think so, if Parliament will give us the powers we seek to obtain.

1499. In what you have told us of your practice in Edinburgh, have you spoken only of cattle, or have you included sheep also ?—I have spoken of both, but we rarely find the sheep infected, very rarely indeed in Edinburgh. And during the last 10 or 12 years I have only seen a couple of calves infected. Pigs are frequently infected by tuberculosis, but as far as my experience goes I have been called upon to adjudicate in very few cases of tuberculosis in sheep.

1500. You are speaking of a period that has comprised the slaughter of a very large number of cattle ?—Yes, very large.

1501. Are you able to say how many ?—I cannot say exactly, but it has been a very large number indeed.

1502. Can you give us the number of carcases condemned ?—The total number of carcases of beef condemned as unfit for human food in consequence of being infected with tuberculosis ?

1503. Yes ?—In 1888 there 310 carcases condemned, and 352 in 1889. I ought to have brought with me a list of the total number condemned during a series of years, but I find that I have neglected to do so; but I will furnish the Commission with a list giving an account of the total number of carcases of all animals brought into our markets and killed and condemned.

1504. Will you state the number of those which were found free from disease, as well as those which were found to be tuberculous ?—Yes, I can do that.

1505. You will be good enough to send us a complete list ?—Yes; from the year 1887 onwards. Before that time the statistics were very carelessly kept; all the different diseases were strung together.

1506. You will give us a list of the cases of calves and sheep as well as of cattle ?—Yes, I will take care to provide a list of each separately.

1507. Have you formed any opinion as to the comparative immunity of sheep from tuberculosis ? How does it come about that mutton does not seem to be infected with tubercle in the same way that beef does ?—I cannot explain, except that it may arise from the open-air life the sheep lead as compared with our dairy cattle.

1508. But the sheep and the cattle may be feeding together in the Craigintinny Meadows ?—No animal is allowed to graze in the meadows. The grass is cut and conveyed from the meadows into the town. As far as my experience goes the tuberculosis is chiefly a disease of dairy cows, and the result of what has taken place since the order under the Contagious Diseases Act was put in force in September last has certainly opened my eyes. I found that the cows in all of our dairies were more or less infected, and that the milk also must have been more or less unfit to be distributed among a population like that of Edinburgh. I have been startled at the results of the examination.

1509. (*Chairman.*) Is it a new phenomenon or not?—Not at all. It has been going on, I should say, for years, but our eyes have now become open to it. The discovery is entirely due to the recent action of the Government, which directed the slaughter of the animals. In our establishments it has been a very rare thing to find a dairy cow without exhibiting a trace of tuberculosis, and I have no doubt that that is the general condition of the dairy cows of the country.

1510. You think that all of them are infected to a greater or less extent with tuberculosis ?—Yes.

1511. (*Dr. Buchanan.*) You have been giving us the results of your experience essentially in connexion with dairy cows ?—Certainly, of dairy cows.

1512. Dairy cows kept in the cow-houses of Edinburgh ?—Yes.

1513. Have you any corresponding facts to give us concerning the dairy cows on farms away from Edinburgh ?—I may say that sometimes the stock in them has been destroyed on account of being infected with tuberculosis. But my experience with regard to country cows is more limited than in the case of the dairy cows kept in Edinburgh. I must confess, however, that tuberculosis does not appear to be as common among that kind of stock as among the dairy cows in Edinburgh.

1514. It does not seem to be so common ?—No, not nearly.

1515. But even then it would be much more common among oxen than among sheep ?—Undoubtedly we find it so.

1516. Can you make any suggestion to us as to the reason of that difference ?—No, I cannot.

1517. I notice that you attach considerable importance to the conditions under which the animals live. I understand you to say that the dairy cows in Edinburgh live in ill-ventilated sheds ?—Yes, that is so.

1518. Do you think the reason why sheep and some oxen escape is that they enjoy better ventilation ?—Yes, I do.

1519. They get better ventilation on the farms than in the crowded cowsheds of Edinburgh ?—Yes.

1520. And you think that their greater immunity from disease is due to that fact ?—Yes, I think it is.

1521. Is it an important element of difference ?—Undoubtedly. The freer ventilation, and the healthier condition under which they live in the country as compared with towns is undoubtedly an important element in the case of tuberculous disease.

1522. Is the legislation of Scotland deficient in regard to the supervision of cowsheds and dairies as compared with England ?—It is, and chiefly on this account: because we have only recently had given to us the County Council Act, which compels the local authorities to appoint medical officers of health. We are just getting over that difficulty now, and are appointing in the Scottish counties and burghs efficient medical officers of health, such as you have

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in England. I believe that after they have been appointed they will have the cowsheds better attended to than they have been in the past. That provision has been a dead letter hitherto, so far as Scotland is concerned.

1523. There is only one further question that I will trouble you with, Dr. Littlejohn. I have asked several witnesses if they can make any suggestion to us as to the direction in which we are to look for evidence of the mode of entry of tuberculosis into the body. I want to know whether we can judge or have any test we can apply to enable us to judge of the tubercle having entered by the food, or in any other way; probably by the lungs. Can you tell us whether there is any pathological or other test which we can apply which may enable us to arrive at a decision upon that point?—I cannot, except of course the suggestion that the intestinal tract should be carefully examined by specially skilled pathologists. I know that investigations are going on every day, and that every day is adding to the precision of our methods of examination. I have no doubt that if the intestinal tract were carefully examined, there would be found in it *tubercle-bacilli* or spores that have passed through the walls of the intestines, and which may be actually found in some of the glands. Then again, this Commission might issue instructions directing a careful examination to be made of the flesh of animals such as might enable us to make out any specially diseased condition, microscopic or otherwise, to guide us as to our conduct in future.

1524. We want, in the first instance, to make out what we can in reference to the mode of entry of the tubercle into the human body by way of food as compared with its entry by other ways, and particularly by the lungs. We wish to find out, if we can, some test to apply to an infected body to show by which way, or by which channel the tubercle was received. Do you think we can hope to find that out, or can you suggest any way by which we could arrive at a conclusion?—I am afraid not, because the varieties of tuberculosis as seen in different animals are something marvellous.

1525. I am speaking now entirely of man?—You confine your question to the entry of tubercle into a human being.

1526. Yes. How should we proceed in the case of a given tuberculous human being? How should we recognise the reception of the tubercle by the digestive tract, or by the respiratory tract?—That is a question which it is exceedingly difficult to answer. Mesenteric disease is very prevalent in childhood, and it certainly begins in the intestines. That is all that I can say, but I do not think I am qualified to express a decided opinion.

1527. (*Prof. B. Sanderson.*) The very interesting pathological facts you have given us, Dr. Littlejohn, as to milk-giving cows in Edinburgh will be published, I presume?—First of all I propose to lay them before the Corporation of Edinburgh. I will submit them to the magistrates, and send a copy to the secretary of the Commission.

1528. How are the pathological investigations carried out in Edinburgh? By what officers?—First of all we have four inspectors. One of them is a veterinary inspector, and another a person who was engaged in the butchering trade. Behind them are two principals of our Veterinary Colleges—Principal Whalley and Principal Williams, and behind them, again, is myself.

1529. Do these four persons form a staff acting under your direction?—Yes, in cases of doubt. In such cases I am empowered by the magistrates to call in one of the principals of the veterinary colleges we have in Edinburgh, but it is comparatively seldom that that is done.

1530. It is an arrangement and not an official system?—It is recognised by the magistrates, and I must obey the orders of the magistrates. Their order to me is that, in any case of doubt or difficulty that is likely to occur and to be carried into a court of law, I should have my opinion strengthened by one of the principals of the Veterinary College. But acting under me are the four market inspectors I have mentioned, one of whom is a regularly passed member of the Royal College of Veterinary Surgeons.

1531. Who has the responsibility of determining that tuberculous meat shall not be sold?—In the first instance, the inspector. It may be a flagrant case, in which case the owner of the carcase at once gives way and allows it to be condemned. If, on the other hand, he insists that the meat is fit for consumption, in all probability I should be sent for. I visit the slaughter-houses twice weekly. The owner, as I say, may insist on my being specially called in. If he is not satisfied we call in other evidence, and we give him every facility for calling in evidence on his own side.

1532. Do you think any good would be done if the authorities were to insist upon a thorough examination of the milk-giving cows during their lives?—That is part of the investigation which has never yet been undertaken in Edinburgh.

1533. Nor anywhere else?—I believe not.

1534. Do you think it ought to be done?—Yes, I have been pressing it upon magistrates of Edinburgh, and I am anxious that the Corporation should pay for the investigation.

1535. Have you thought anything as to the conditions under which a diagnosis might be made of tuberculous animals during life?—Yes, but there are other matters to be taken into consideration also. Unless a cow shows emaciation, there is nothing to give us a hint that tuberculosis is there.

1536. Of course we have now the method?—You mean Dr. Koch's method?

1537. Yes?—But we shall have to prove it first.

1538. In Edinburgh, as elsewhere, the power of ordering an animal to be killed depends entirely, I presume, on there being reason to suppose that it is "suffering from some disease which is named in "the Contagious Diseases Act"?—Yes. I have no power, nor has the inspector any power, to visit a cow-house and say, "There is an animal which we "suspect to be infected with tuberculosis. We will "have that animal out and killed." That is beyond our power. The owner would at once say, "You "have no right to do so." But that will become our duty if we pass our new Bill which we are going to promote in Parliament this session. The word "animal," which exists, I believe, in the English Act, will give us power to take any animal suffering from disease which we may find in the market or in the cow-house, and order it to be examined and slaughtered. If we make a mistake the owner will be entitled to be compensated, but if we make no mistake and find that the meat is unmarketable or unfit for human consumption, the Act says that the owner shall not be entitled to compensation.

1539. (*Chairman.*) What do you mean by saying, "The Bill we are going to promote?" Who are going to promote it?—The Corporation of Edinburgh.

1540. (*Prof. B. Sanderson.*) Am I correct in understanding you to say that you have never yet ordered an animal to be killed on account of tuberculosis?—Yes.

1541. You have no power to do so?—No. If we see an animal which presents a suspicious appearance, and make a representation about it, what does the owner do? He just laughs at us and takes it away from Edinburgh to Glasgow where the regulations are less strict and where it is easily disposed of. We are more particular in Edinburgh than in any other town owing to our large juvenile population.

1542. In all the cases where animals are now killed they are killed on the ground that they are infected with pleuro-pneumonia?—Yes, or else a dairyman wishing to reduce his stock takes advantage of the public abattoir to have a portion of his stock killed, as we have no private killing houses. Of all the abominations that exist in towns one of the worst is the private killing-house. Unless there happens to be a public abattoir it is necessary of course to make

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use of private killing-houses, and they are not only ill-managed, but are allowed to get into a very bad state.

1543. All cows that are killed by the authorities and are not slaughtered by their owners are killed on the suspicion that they are infected with pleuro-pneumonia?—That is so.

1544. (*Prof. Brown.*) You say, Dr. Littlejohn, that if you were to find the glands infected, you would consider the meat unwholesome?—Yes, it would depend in a great measure upon the condition of the glands.

1545. If you saw signs of tuberculosis in a single intestinal gland, while the other parts of the animal appeared to be good, would you allow the meat to go into consumption? — Yes, probably; but I have always set my foot down whenever I have found the mesenteric glands infected. Wherever the udder is infected, we are certain to condemn.

1546. I have no doubt you are aware that you sometimes get *tubercle-bacilli* in an ancillary gland, when you see them in no other part?—Yes, so I believe.

1547. Under that condition, would you condemn the entire carcase of an animal?—Yes.

1548. When there is no power of inspecting the ancillary glands?—It would be very difficult to do so.

1549. Is it not possible for one person to eat meat and to be found free from tuberculosis, whereas another person eating the same meat might be discovered to be tuberculous?—Yes, I think so.

1550. You have said that you have seen meat which no pathologist would declare to have come from a tuberculous animal, although you might know that it had?—Yes, I would undertake to pick out a piece of meat and defy even a skilled person to say that it came from a tuberculous animal.

1551. I understood you to say that even a bacteriological survey would fail to detect the fact?—You must have have misunderstood me. I think that a scientific investigation would establish the fact.

1552. You are aware that in much of the meat taken from tuberculous animals the peritoneum is covered with tuberculous nodules, while a portion of the meat from the diaphragm may be examined without discovering a trace of tuberculosis?—So I believe; but I hope that fresh methods of examination will be discovered that will get rid of all difficulty.

1553. In the meanwhile, are you aware that animals are frequently fed on such meat without harm?—I have no doubt—the lower animals.

1554. I mean the lower animals—the small animals —which have been treated experimentally?—I think it is quite possible.

1555. Should you consider that in the event of its being proved that meat free from tubercle is harmless to the animal experimented upon—would you consider it safe for this Commission to draw the conclusion that it might be given harmless, in a raw state, to a human being?—Decidedly not.

1556. Would you protest against meat from an animal which apparently was sound and in good condition, but which nevertheless had imparted tuberculosis to other animals inoculated with it—would you protest against such meat being allowed to go into consumption?—Yes, I think it is a disgrace to civilization that it should be supplied as food to human beings.

1557. You misunderstand my question. If it is proved that meat taken from a tuberculous animal, when given to one of the small animals, produces no mischief, do you think it would be safe to conclude, from that fact, that it might be given to a human being without doing mischief?—No, I do not think it would be safe.

1558. Then you do not think it is safe to draw conclusions which are based upon experiments on animals?—As a health officer, I should decidedly say no.

1559. Nevertheless, you think that something might be done in the way of experimenting upon criminals?—Undoubtedly.

1560. Do you think it would be satisfactory to have experiments upon two or three persons only?—To a certain extent I think it would be satisfactory.

1561. How would you know that the criminals experimented upon were themselves free from infection?—No doubt they might be liable to it, but I think that the test might be made a reliable one.

1562. Would not scientific men demand that the experiment should be tried in a great number of instances?—Undoubtedly they would, and that forms one of the objections to carrying out my suggestion.

1563. I understand you to say that no case ever came under your knowledge where you could trace the existence of the disease of tuberculosis in man to the consumption of infected meat or milk?—No.

1564. Although you are satisfied that such meat and milk are consumed in large quantities?—Such is my judgment.

1565. Have you the information which would enable us to ascertain whether consumption has decreased in Edinburgh during the last quarter of a century?—I think it has.

1566. To what is the decrease due?—I think it is due chiefly to the action of the corporation. They have already expended something like half a million of money in letting in air and light to the inhabitants of the poorer districts of Edinburgh. Every day the corporation are improving the conditions of life among the poor, and diminishing the risk of consumption.

1567. You look upon the sanitary measures which the Corporation of Edinburgh are carrying out as counteracting, to a large extent, the injurious effects of tuberculous meat and milk?—There can be no doubt of that. The city is now thoroughly drained, which is one very important thing.

1568. But, nevertheless, you maintain that the meat and milk supplied to the people of Edinburgh continue to contain the injurious qualities you have referred to?—Yes.

1569. And if you could get rid of those injurious qualities you would be in a better condition still?—Yes. A very large sum of money has already been spent by the Corporation of Edinburgh, quite 500,000*l.*, in improving the conditions of life among the poor, and the result has been to lessen the tendency to contract tuberculosis.

1570. Of course you have no means whatever of preventing or even of limiting in any way the hereditary tendency to the transmission of the disease?—No.

1571. You cannot prevent tuberculous persons from marrying?—No, but I look upon that as an important consideration.

1572. Nor have you the advantage which the agriculturists have of being able to select the parents? —I am sorry to say that we have not.

1573. In speaking of the infection of meat you made a very remarkable statement, which is very interesting to me. You said you thought that when the carcases are sent to a killing house or depôt, the authorities insist upon the offal being brought with them?—Undoubtedly; that in my opinion is very important.

1574. Do you happen to know by what machinery that is ensured?—The farmers have repeatedly been put to a heavy loss from not attending to that requirement. They have now become educated, and they carefully attend to it.

1575. Do you know what machinery is in use to secure that the liver, heart, and lungs are sent with the carcase?—No, we trust very much to the local inspector—to his honour.

1576. Can you be certain that false lungs may not have been sent?—No, that is one of our difficulties. I do not say that false lungs may not be sent in some cases, but in a small country like Scotland, the man who sends the carcase is known to the country side, and it is generally known whether, from bad arrangements on the farm, the stock is bad and prone to tuberculosis or not.

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1577. There are no means that you know of to prevent the change of the offal during transit?—No, and I am afraid that it may be done in any stage of transit.

1578. And if you could trace the operation of the system in regard to the thousands of carcases sent into Edinburgh, I suppose you would find that it does happen occasionally?—Yes, I have not the slightest doubt of it.

1579. (*Dr. Payne.*) Has there been any test discovered by which you can recognise tuberculous meat?—Not as yet, but I live in the hope that there may be.

1580. You cannot give us any idea of the direction in which you would look for it?—No, I leave it to others.

1581. Have you had any experience of the communication of tuberculous disease from mankind to animals?—No.

1582. Do you think it is possible for a person suffering from tuberculosis—a servant or dairyman, for instance—to communicate the disease to the animals they attend?—No doubt it is within the bounds of possibility, but when I see the condition in which the dairy stock is being reared and live, I am not surprised at anything that may happen to it. The cow sheds are loaded with organic matter, and there is a marked absence of proper ventilation.

The witness withdrew.

The following letter and statistics were received from Dr. Littlejohn for the information of the Commission:—

Dear Sir, Edinburgh, January 1, 1891.

I now beg to hand you the statistics made up to the end of the year.

Yours truly,
(Signed) Henry D. Littlejohn, M.D.

P.S.—The paper apart deals with an exhaustive examination of our Edinburgh dairies in connection with the recent order of the Board of Agriculture.—H. D. L.

Inspector of Markets Office, Police Chambers, Edinburgh, 5th December, 1890.

Total Numbers of Carcases of Beef condemned as unfit for Human Food, with the numbers of those condemned as being affected with Tuberculosis, during the years 1887-88-89-90, inclusive.

Year.	Month.	Total.	Tuberculosis.	Remarks.
1887	January	21	2	
,,	February	31	4	
,,	March	22	1	
,,	April	28	4	
,,	May	45	5	(2 calves).
,,	June	27	2	
,,	July	18 &c.	1 piece	
,,	August	22	5½	
,,	September	23	4	(1 pig).
,,	October	26½	4½	
,,	November	23½	9	
,,	December	23	4	
		310 &c.	45 &c.	

Year.	Month.	Total.	Tuberculosis.	Remarks.
1888	January	30	17	
,,	February	25	10	(1 pig).
,,	March	23	7	
,,	April	24½	5	
,,	May	26	6	
,,	June	31½	13	
,,	July	24	5	
,,	August	18	7	(1 pig).
,,	September	25	7	(1 pig).
,,	October	13½	7	
,,	November	24	7	(1 pig).
,,	December	24	1	
		288½	92	

Year.	Month.	Total.	Tuberculosis.	Remarks.
1889	January	27½	5	
,,	February	25	2	
,,	March	18	5	
,,	April	43	13¼	
,,	May	46	12	
,,	June	48	18	
,,	July	41	15	
,,	August	29	7	
,,	September	20	7½	(1 pig).
,,	October	25	8	
,,	November	18	3	
,,	December	11½	2	
		352	97¾	

Year.	Month.	Total.	Tuberculosis.	Remarks.
1890	January	33¼	8	(1 pig).
,,	February	20	9	
,,	March	21	7	
,,	April	27	11	
,,	May	26	4	
,,	June	40	9	
,,	July	35	13	
,,	August	23	7	
,,	September	28	10	
,,	October	41	14	
,,	November	101	63	(1 pig).
,,	December	12	5	
		407¼	160	

Wm. Sevullar.
F. A. Porteous, M.R.C.V.S.

Percentages of Tuberculous Beef Carcases condemned.

1887.—14 per cent. of all beef carcases condemned as unfit for human food were considered so on account of tuberculosis.

1888.—32 per cent. of all beef carcases condemned as unfit for human food were considered so on account of tuberculosis.

1889.—27½ per cent. of all beef carcases condemned as unfit for human food were considered so on account of tuberculosis.

1890.—39 per cent. of all beef carcases condemned as unfit for human food were considered so on account of tuberculosis.

Wm. Sevullar,
F. A. Porteous, M.R.C.V.S.

Dr. H. D. Littlejohn, M.D., F.R.C.S.

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INSPECTOR of MARKETS OFFICE, POLICE CHAMBERS, EDINBURGH, 5th December, 1890.

REPORT on the POST MORTEM EXAMINATION of THREE HUNDRED DAIRY COWS in EDINBURGH.

No.	——	Remarks.
	Mrs. ROBERTSON, Balbernie Place.	
	No. 1 Byre.	
1	- - - - - -	Healthy.
2	- - - - - -	„
3	- - - - - -	„
4	- - - - - -	„
5	- - - - - -	„
	No. 2 Byre.	
6	- - - - - -	Healthy.
7	- - - - - -	„
8	- - - - - -	„
8	- - - - - -	„
10	Tuberculosis, extensive.	—
11	- - - - - -	Healthy.
12	- - - - - -	„
13	Tuberculosis, extensive.	—
14	- - - - - -	Healthy.
15	- - - - - -	„
16	- - - - - -	„
	ROBERT LIDDLE, Dorset Place.	
1	Tuberculosis.	—
2	- - - - - -	Healthy.
3	- - - - - -	„
4	Tuberculosis, extensive.	—
5	Tuberculosis.	—
6	- - - - - -	Healthy.
7	- - - - - -	p.p.c.
8	- - - - - -	„
9	- - - - - -	Healthy.
	J. LOCKHART, Blandfield.	
	No. 1 Byre.	
1	- - - - - -	Healthy.
2	- - - - - -	„
3	- - - - - -	„
4	- - - - - -	„
5	- - - - - -	„
6	- - - - - -	„
7	- - - - - -	„
8	- - - - - -	„
9	- - - - - -	„
10	- - - - - -	„
11	- - - - - -	„
12	Tuberculosis.	—
13	- - - - - -	Healthy.
14	Tuberculosis.	—
15	Tuberculosis.	—
16	- - - - - -	Healthy.
17	Tuberculosis.	—
18	Tuberculosis, slight.	—
19	Tuberculosis.	—
	No. 2 Byre.	
20	- - - - - -	Healthy.
21	- - - - - -	„
22	Tuberculosis.	—
23	Tuberculosis.	—
24	Tuberculosis.	—
25	- - - - - -	Healthy.
26	- - - - - -	„
27	- - - - - -	„
28	- - - - - -	„
29	- - - - - -	„
30	- - - - - -	„
31	Tuberculosis.	—
32	- - - - - -	Healthy.
33	Tuberculosis.	—
34	Tuberculosis, slight.	—
35	- - - - - -	Healthy.
36	Tuberculosis.	—
37	- - - - - -	Healthy.
38	- - - - - -	„
39	Tuberculosis.	—
40	Tuberculosis, slight.	—
41	Tuberculosis.	—
42	Tuberculosis, slight.	—
43	Tuberculosis.	—
44	Tuberculosis.	—
45	Tuberculosis.	—
46	- - - - - -	Healthy.
47	Tuberculosis, extensive.	—
48	Tuberculosis, slight.	—
49	Tuberculosis, slight.	—
50	Tuberculosis.	—
	No. 2 Byre—*continued.*	
51	- - - - - -	Healthy.
52	Tuberculosis.	—
53	- - - - - -	Healthy.
54	- - - - - -	p.p.c.
55	- - - - - -	Healthy.
56	Tuberculosis.	—
57	Tuberculosis, extensive.	—
58	- - - - - -	Healthy.
59	- - - - - -	„
	ROBERTSON, Damhead.	
1	- - - - - -	Healthy.
2	- - - - - -	„
3	- - - - - -	„
4	- - - - - -	„
5	- - - - - -	„
6	- - - - - -	„
7	Tuberculosis, slight.	—
8	Tuberculosis, slight.	—
9	Tuberculosis.	—
10	Tuberculosis, extensive.	—
11	Tuberculosis.	—
12	Tuberculosis, slight.	—
13	Tuberculosis.	—
14	Tuberculosis.	—
15	- - - - - -	Healthy.
16	Tuberculosis.	—
17	Tuberculosis, slight.	—
18	Tuberculosis.	—
19	Tuberculosis, slight.	—
20	Tuberculosis, slight.	—
21	Tuberculosis, slight.	—
22	- - - - - -	Healthy.
23	- - - - - -	„
24	- - - - - -	„
25	Tuberculosis.	—
26	Tuberculosis.	—
27	- - - - - -	Healthy.
28	- - - - - -	„
29	Tuberculosis.	—
30	Tuberculosis.	—
31	- - - - - -	Healthy.
32	Tuberculosis, slight.	—
33	Tuberculosis.	—
34	Tuberculosis, extensive.	—
35	Tuberculosis, slight.	—
36	- - - - - -	Healthy.
37	Tuberculosis, slight.	—
38	- - - - - -	Healthy.
39	- - - - - -	„
40	- - - - - -	„
41	Tuberculosis, slight.	—
42	- - - - - -	Healthy.
43	Tuberculosis, slight.	—
44	Tuberculosis, slight.	—
45	Tuberculosis, slight.	—
46	Tuberculosis.	—
47	- - - - - -	Healthy.
48	Tuberculosis.	—
49	- - - - - -	—
	J. CHARLESTON, Gorgie.	
1	Tuberculosis.	—
2	- - - - - -	Healthy.
3	- - - - - -	p.p.c.
4	- - - - - -	Healthy.
5	Tuberculosis, slight.	—
6	Tuberculosis.	—
7	Tuberculosis.	—
8	- - - - - -	p.p.c.
9	Tuberculosis, slight.	—
10	- - - - - -	Healthy.
11	- - - - - -	p.p.c.
12	Tuberculosis, slight.	—
13	- - - - - -	Healthy.
14	- - - - - -	„
15	- - - - - -	„
16	- - - - - -	p.p.c.
	MCPHERSON, Gorgie.	
1	- - - - - -	Healthy.
2	- - - - - -	„
3	- - - - - -	„
4	- - - - - -	„
5	Tuberculosis.	—
6	Tuberculosis, slight.	—

No.	——	Remarks.
	McPherson, Gorgie—*continued.*	
7	- - - - - -	Healthy.
8	- - - - - -	"
9	- - - - - -	"
10	- - - - - -	"
11	Tuberculosis.	—
12	- - - - - -	Healthy.
13	Tuberculosis.	—
14	Tuberculosis.	—
15	- - - - - -	Healthy.
16	Tuberculosis.	—
17	- - - - - -	Healthy.
18	- - - - - -	"
19	- - - - - -	"
20	- - - - - -	"
21	- - - - - -	"
22	Tuberculosis.	—
23	- - - - - -	Healthy.
24	- - - - - -	"
25	- - - - - -	"
26	- - - - - -	"
27	- - - - - -	"
28	Tuberculosis.	—
29	- - - - - -	Healthy.
30	- - - - - -	"
31	- - - - - -	"
32	- - - - - -	"
33	- - - - - -	"
34	Tuberculosis.	—
35	- - - - - -	Healthy.
36	- - - - - -	"
37	- - - - - -	"
38	- - - - - -	"
39	Tuberculosis.	—
40	- - - - - -	Healthy.
41	- - - - - -	"
42	Tuberculosis, slight.	—
43	- - - - - -	Healthy.
44	- - - - - -	"
	J. Linklater, Silvermills.	
1	- - - - - -	Healthy.
2	- - - - - -	"
3	- - - - - -	"
4	- - - - - -	"
5	Tuberculosis.	—
6	- - - - - -	Healthy.
7	Tuberculosis.	—
8	- - - - - -	Healthy.
9	- - - - - -	"
10	- - - - - -	"
11	- - - - - -	"
12	- - - - - -	"
13	- - - - - -	"
14	- - - - - -	"
15	Tuberculosis.	—
16	- - - - - -	Healthy.
17	Tuberculosis, extensive.	—
18	Tuberculosis, extensive.	—
19	- - - - - -	Healthy.
20	Tuberculosis, extensive.	—
21	Tuberculosis, slight.	—
22	Tuberculosis, slight.	—
23	Tuberculosis, extensive.	—
24	- - - - - -	Healthy.
25	- - - - - -	"
	Mrs. Forrest, George Square Lane.	
1	Tuberculosis.	—
2	- - - - - -	Healthy.
3	Tuberculosis, slight.	—
4	- - - - - -	p.p.c.
5	- - - - - -	"
6	- - - - - -	"
7	- - - - - -	Healthy.
	D. Craigie, Dorset Place.	
1	- - - - - -	Healthy
2	Tuberculosis, G.L.	—
3	Tuberculosis, general.	—
4	Tuberculosis, extensive.	—

No.	——	Remarks.
	D. Craigie, Dorset Place—*continued.*	
5	Tuberculosis, general.	—
6	Tuberculosis, general.	—
7	- - - - - -	Healthy.
8	Tuberculosis, G.L.	—
9	Tuberculosis, general.	—
10	Tuberculosis, general.	—
11	Tuberculosis, G.L.	—
12	Tuberculosis, G., slight.	—
	William Wilson, Silvermills.	
1	- - - - - -	p.p.c.
2	Tuberculosis.	—
3	- - - - - -	Healthy.
4	- - - - - -	p.p.c.
5	- - - - - -	Healthy.
6	- - - - - -	p.p.c.
7	- - - - - -	"
8	Tuberculosis.	—
9	- - - - - -	p.p.c.
10	- - - - - -	Healthy.
11	Tuberculosis.	—
12	- - - - - -	Healthy.
	Inglis, Jock's Lodge.	
1	- - - - - -	Healthy.
2	- - - - - -	"
3	Tuberculosis.	—
4	- - - - - -	Healthy.
5	- - - - - -	"
5	- - - - - -	"
6	- - - - - -	"
7	- - - - - -	"
8	- - - - - -	"
9	Tuberculosis.	—
10	- - - - - -	Healthy.
11	- - - - - -	"
12	Tuberculosis.	—
13	- - - - - -	Healthy.
14	Tuberculosis.	—
15	Tuberculosis.	—
16	- - - - - -	Healthy.
17	Tuberculosis.	—
18	Tuberculosis.	—
19	Tuberculosis.	—
20	- - - - - -	Healthy.
21	Tuberculosis.	—
22	- - - - - -	Healthy.
23	Tuberculosis.	—
24	- - - - - -	Healthy.
25	- - - - - -	"
26	- - - - - -	"
27	- - - - - -	"
28	- - - - - -	"
29	- - - - - -	"
30	- - - - - -	"
	Mr. Froud, Gorgie.	
1	Tuberculosis.	—
2	- - - - - -	Healthy.
3	Tuberculosis.	—
4	- - - - - -	Healthy.
5	- - - - - -	p.p.c.
6	Tuberculosis, slight.	—
7	Tuberculosis.	—
8	- - - - - -	Healthy.
9	Tuberculosis.	—
10	- - - - - -	Healthy.
11	- - - - - -	"
12	- - - - - -	"
13	- - - - - -	"
14	- - - - - -	"
	Mr. Messer, Restalrig.	
1	Tuberculosis.	—
2	Tuberculosis.	—
3	- - - - - -	Healthy.
4	- - - - - -	"
5	Tuberculosis.	—
6	- - - - - -	Healthy.
Calf.	- - - - - -	"

Percentage Abstract of 300 cows slaughtered :—

54⅔ per cent. healthy.
40 ,, tuberculous.
5⅓ ,, pleuro-pneumonic.
100 ,,

Dr. H. D. Littlejohn, M.D., F.R.C.S.

10 Dec. 1890.

ABSTRACT.

Owner.	Date.	Slaughtered.	Healthy.	Tuberculous.	Pleuro-Pneumonic.	Percentage. Tuberculous.
						Per Cent.
Mrs. Robertson	9 September	16	14	2	0	$12\frac{1}{2}$
R. Liddle	13 October	9	4	3	2	$33\frac{1}{3}$
J. Lockhart	1 November	59	31	27	1	46
Robertson	13 "	49	20	29	0	59
J. Charleston	15 "	16	6	6	4	$37\frac{1}{2}$
McPherson	17 "	44	33	11	0	25
J. Linklater	20 "	25	16	9	0	36
Mrs. Forrest	15 "	7	2	2	3	28
D. Craigie	17 "	12	2	10	0	83
W. Wilson	22 "	12	4	3	5	25
Inglis	1 December	30	20	10	0	$33\frac{1}{3}$
Froud	3 "	14	8	5	1	$35\frac{1}{2}$
Messer	4 "	7	4	3	0	43
		300	164	120*	16†	—

* 58 carcases passed, the internal organs being destroyed.
62 carcases were totally condemned.
—
120

† $7\frac{1}{4}$ carcases were passed, internal organs destroyed.
$8\frac{3}{4}$ carcases were totally condemned.
—
16

William Sevullar.
T. A. Porteous, M.R.C.V.S.

Inspector of Markets Office, Police Chambers, Edinburgh, 31st December, 1890.

Total Numbers of Cattle, Pigs, and Calves Slaughtered in Edinburgh, with the Numbers of those Condemned on account of Tuberculosis.

Year.	Month.	Cattle.	Pigs.	Calves.	Tuberculosis in		
					Cattle.	Pigs.	Calves.
1887	January	2,507	480	327	2	—	—
"	February	2,334	344	426	5	—	—
"	March	2,681	451	694	2	—	—
"	April	2,392	356	607	6	—	—
"	May	2,515	340	852	3	—	2
"	June	2,146	197	633	2	—	—
"	July	2,124	131	586	1	—	—
"	August	2,363	109	388	6	—	—
"	September	2,484	194	452	3	1	—
"	October	2,610	350	369	6	—	—
"	November	2,959	512	335	8	—	—
"	December	2,550	604	401	4	—	—
	Totals	29,665	4,068	6,070	48	1	2

Year.	Month.	Cattle.	Pigs.	Calves.	Tuberculosis in		
					Cattle.	Pigs.	Calves.
1888	January	2,722	521	430	17	—	—
"	February	2,276	510	484	10	1	—
"	March	2,266	446	573	7	—	—
"	April	2,085	317	632	5	—	—
"	May	2,553	261	899	6	—	—
"	June	2,072	257	600	13	—	—
"	July	2,403	198	712	5	—	—
"	August	2,008	195	490	6	1	—
"	September	2,297	247	594	6	1	—
"	October	2,657	484	503	7	—	—
"	November	2,547	530	350	6	1	—
"	December	2,296	616	337	1	—	—
	Totals	28,182	4,582	6,604	89	4	—

Year.	Month.	Cattle.	Pigs.	Calves.	Tuberculosis in		
					Cattle.	Pigs.	Calves.
1889	January	2,558	655	387	5	—	—
"	February	2,179	451	447	2	—	—
"	March	2,154	447	528	5	—	—
"	April	2,404	382	691	14	—	—
"	May	2,066	379	633	12	—	—
"	June	2,094	169	643	18	—	—
"	July	2,316	168	744	15	—	—
"	August	2,134	236	471	7	—	—
"	September	2,071	202	581	7	1	—
"	October	2,539	415	474	8	—	
"	November	2,323	430	323	3	—	—
"	December	2,527	614	323	2	—	—
	Totals	27,365	4,548	6,245	98	1	—

Year.	Month.	Cattle.	Pigs.	Calves.	Tuberculosis in		
					Cattle.	Pigs.	Calves.
1890	January	2,309	480	276	7	1	—
"	February	2,112	422	404	9	—	—
"	March	2,041	470	363	7	—	—
"	April	2,401	497	557	11	—	—
"	May	1,937	388	503	4	—	—
"	June	2,238	287	441	9	—	—
"	July	2,330	262	564	13	—	—
"	August	2,241	228	371	7	—	—
"	September	2,498	256	578	10	—	—
"	October	2,581	531	423	14	—	—
"	November	2,417	497	316	62	1	—
"	December	2,664	655	364	26	3	—
	Totals	27,769	4,973	5,160	179	5	—

F. A. Porteous, M.R.C.V.S.

Professor Victor Horsley, F.R.S., F.R.C.S., Professor of Pathology at University College, London, Superintendent of the Brown Institution, and Assistant Surgeon to University College Hospital, called in and examined.

Prof. V. Horsley, F.R.S., F.R.C.S.

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1583. (*The Chairman.*) Professor Horsley, you are, I believe, professor of pathology at University College?—Yes.

1584. And also superintendent of the Brown Institute?—Yes.

1585. And in addition you are assistant surgeon of University College Hospital?—Yes.

1586. You gave evidence, I think, before the Tuberculosis Committee?—No, I was one of the committee.

1587. I beg your pardon, you were on the committee?—Yes.

1588. Do you regard the report of that committee as conclusive on the subject of the risk there may be to mankind from the consumption of meat and milk, the proceeds of tuberculous animals?—No, I do not.

1589. If you had given evidence yourself, could you have produced any fact or stated any fact to indicate that we might regard the use of such materials proved to come from tuberculous animals as being highly prejudicial to human health?—I do not know that I could have stated any facts that were not common property, that is to say, since I have not entered into any special investigation of the subject, of course what I should have had to communicate would only have been what I had read.

1590. I think that coming from an expert that would have been useful and valuable evidence?—As such I should have been very glad to have given it. But upon that point I understood that the departmental committee was appointed hardly for the special discussion of that subject, but rather for the purpose of considering the prevalence of disease among animals, and the spread of it from animal to animal.

1591. Have you an extensive practice among consumptive patients?—No, I have not.

1592. Have you anything to lay before us that would illustrate the difficult question we have to find an answer to; namely, to what extent, as a matter of fact, is the consumption of meat and milk, the produce of tuberculous animals, injurious to man?—I have, of course, read the subject as thoroughly as possible, and I have conversed with others upon it who have acquired considerable knowledge. The conclusion I have come to is that as regards the possibility of the disease being communicated by milk there is considerable danger, whether the udder of the cow be diseased or not. Secondly, as regards the communication of disease by tuberculous meat, I believe also that there is danger, not so great, but sufficiently great to demand that preventive legislation should be commenced against it.

1593. You accept, I suppose, the discoveries or revelations, if one may call them so, in regard to the *tubercle-bacillus* which have been made during the last four or five years?—Oh, yes, in their entirety And I also accept as conclusive the amount of experimental research which has been practically conducted as to the infective character of meat. What I mean to say is that my own knowledge, and the different investigations which have already been made on this important subject, together with the facts which have been elicited, go to show that the meat is poisonous, and infective in proportion to what one might reasonably suppose to be the proportion of bacilli contained in it—that is to say, that if small quantities of meat — muscle, for example, be taken and an animal inoculated with it, the chance of that animal becoming tuberculous is remote, whereas if a considerable quantity of meat is taken, and inoculation made with the juice is expressed from that quantity of meat, the chance is that tuberculosis would be largely developed; I take it therefore that the extent of the disease would be in proportion to the amount of the bacilli inoculated.

1594. Putting inoculation aside for a moment, what do you say of the risk incurred by ingesting tuberculous meat or milk?—As regards milk, such as raw new milk, I think that the risk would be considerable, but in regard to meat I think the risk would be very much smaller. At the same time I think there is a sufficient amount of risk to justify us in bringing about something in the shape of prevention.

1595. Has consumption increased rapidly during the last half century?—Upon that question I do not know the facts, and I cannot say proportionately what the increase of tuberculosis has been.

1596. It is unfortunately a highly prevalent disease?—Yes, and I think it is very likely to have spread, because it is an infective disease, and one communicated, not only by contact, but by heredity. As no effort has been made to stop it systematically, I should say from *à priori* reasoning that it has probably increased.

1597. Are you prepared to say that if consumption, as a matter of fact, is largely communicated by infection from one person to another, or to a person from an animal; are you prepared to say that, if that be so, consumption would probably be very much more common than it unhappily is?—No, I do not think so.

1598. Why?—Because the chance of infection by contact, that is to say, by the carriage of the poison from one person to another, by ingestion or inhalation, is not so great as that which arises from heredity.

1599. You believe that tuberculosis is an hereditary disease? — Yes, I do. I believe that the virus is handed down directly from the parent to the child. Personally, I believe more than the view which is very commonly held, namely, that the hereditary element is simply a transference from the parent to the child of a peculiar constitutional state with a predisposition to the growth of tubercle.

1600. Is not that inconsistent with the idea that the bacilli are flying about which introduce the poison into the system?—No; because according to my view the *tubercle-bacillus* is actually transferred from the parent to the child.

1601. Although the disease may not manifest itself for many years?—Oh, yes. I should be quite within the limits of truth in stating that, because there are instances on record of the disease having been called out by a blow, when there had previously been no reason to suppose that the infection existed.

1602. Comparing the infectiveness of consumption with that of other well known contagious diseases—take scarlatina, for instance—is there not this striking fact that we have consumption spread all over the kingdom, whereas the disease of scarlatina appears only here and there, and in the cases in which it does appear it is highly virulent and infective. It is not the same with consumption, and I want to ascertain, if possible, what there is to prevent it from being universally infective. How is it that scarlatina is communicated in one way and consumption in another?—The striking difference is due to the following factors, first that the action of the virus in the two diseases is quite different. The infection in the one case is extremely short, and the effect produced is very acute, whereas in tuberculosis it lasts very long, and the effect produced, except in rare instances, becomes of a chronic character. Consequently, the individual attacked does not forsake his usual occupations, and is not confined to one place. The next factor is that in the case of scarlatina the disease is usually recognised at once, and the patient is isolated from other persons, and immediate steps are taken, as a rule, to prevent the spread of infection, whereas in tuberculosis an exactly opposite course is taken. Therefore, one would expect, *à priori*, to find that scarlatina

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would be a highly localised disease, speaking topographically, whereas tuberculosis would be thoroughly generalised.

1603. Do you agree with other witnesses who have appeared before us, that there can be no tuberculosis in mankind without the introduction of the bacillus into the body?—Oh, quite.

1604. But you differ in your view that it may be latent in its effect for many years?—I did not know that I differed from other witnesses on that point.

1605. Quite so, but some witnesses have hesitated to admit that there can be bacilli in a child immediately after birth. Do you entertain the same view?—Perhaps I ought to state to the Commission the facts upon which I base my opinion. The facts are as follows: In the first place the bacillus has been observed in the ovum, not in the case of a human subject, but in the lower animals. In many instances the new born animal has been found to possess already the developed disease; and then there are a large number of cases in which the disease reaches its height within a month or six weeks after the birth. *Post-mortem* examinations have shown that it has been an old variety of disease, and that there has been caseation, showing that it must have commenced in intra-uterine life. Then, as regards the other point, the bacilli lying hid and latent, I may state from facts which I have not only read, but which have come under my own notice, especially in regard to the outbreaks of local tuberculosis consequent upon traumatism. In these cases, at the commencement a general swelling accompanies the growth of the bacilli in the tissues, and, as I have said, I have known instances of tuberculosis being developed from the effects of a blow. After the inflammatory effects of the blow have passed off, tuberculosis has been set up. Several cases of that kind have occurred which have come under my special notice, as well as the notice of others, and in every case it was shown that it was impossible that the patient could have been infected just at the time the blow occurred.

1606. Do you mean a blow on the chest?—No, on the bones or the extremities; the joints of the foot more especially.

1607. (*Dr. Payne.*) With regard to the experiments in transmitting tuberculosis to animals by means of meat, have you ever seen or heard of any important results having been derived from feeding experiments as distinguished from inoculation?—No; I have no knowledge of any very extensive feeding experiments.

1608. Inoculation, I suppose, I may regard as the test for the tubercle?—Certainly.

1609. Its effects, I presume, are equally direct, and perhaps more direct than any other positive experiment?—Yes, I think so.

1610. And also under proper conditions it is an exact test?—Yes, certainly.

1611. What I mean is, that no negative result following an experiment is to be regarded as important?—It may be regarded as important, but not as absolute.

1612. If there were repeated experiments of this kind with continuous negative results, might they be taken as establishing the absence of the virus?—Yes.

1613. If you wanted to try the effect of tuberculous or suspected tuberculous meat as a food in the case of an animal, what kind of animal would you try it upon?—I should try it upon rodents, because they are particularly sensitive, and also upon pigs.

1614–6. Sensitive to tuberculosis?—Yes.

1617. (*Chairman.*) Pigs?—Yes.

1618. (*Dr. Payne.*) Yes, they seem to me to be most suitable for such experiments. The condition of the digestive organs in rabbits is very different?—Yes, that is so; and I have found that you cannot give rodents sufficient quantities of food from tuberculous meat such as might produce acute tuberculosis without their suffering from toxic symptoms. I should say that by the food I speak of I mean the juice expressed from a considerable quantity of tuberculous meat.

1619. Suppose that you had a series of negative results from feeding rodents with tuberculous meat, would you regard them as conclusive?—Yes, I think so. It is very well known that the gastric juice has very little or no action upon the *tubercle-bacilli.* I think, moreover, if I am not mistaken, that the gastric juice employed in such experiments has been carnivorous gastric juice.

1620. Do you know whether experiments upon any class of animals have been made which showed that the tuberculous disease had been acquired from food?—I cannot say offhand, but I could if I were to look up the literature upon the subject.

1621. Animals of any class, I said?—Yes, I think I remember one case—Peuch's experiments on pigs. He obtained positive results from feeding pigs.

1622. With tubercular flesh?—Yes, with tubercular flesh.

1623. Do you know anything about the modes of making tuberculous milk harmless? Do you think that boiling would be sufficient?—I am informed so, but I do not know from my own experience.

1624. What kind of experiments would you carry out in order to test whether meat, when it became tuberculous, could be made harmless by any kind of cooking experiment?—I do not think that any cooking of meat would be satisfactory unless it was in the nature of boiling, and the meat had been previously divided into small portions.

1625. Have there been any experiments in that direction?—Yes, some of the earliest experiments of Toussaint were upon half cooked meat, and I have myself seen a tuberculous nodule brought before the departmental committee in the middle of a cooked joint of meat.

1626. (*Chairman.*) Do you draw a distinction between a piece of cooked tuberculous meat with the tubercle actually in it, and a piece of otherwise healthy-looking meat which was known to come from an animal that was known to be infected with tuberculosis?—I ought, perhaps, to have drawn that distinction, because I take it that the penetration by heat of a tuberculous piece of meat might produce some effect upon it, but I do not think it would influence one's judgment if one were required to form a general opinion on the subject. I do not think that any mere roasting before a fire would ensure the destruction of the tuberculous virus, whether it was contained in a tuberculous nodule or not, and I think that penetration by heat before an open fire ought not be regarded as sufficient for disinfecting purposes.

1627. Do you think that if it has one nodule in it that is perceptible by means of a microscope it is still dangerous?—Yes.

1628. If the bacillus theory is to be relied upon, can there be any infection by means of meat which has no tubercle or bacilli in it?—Oh, no, certainly not.

1629. (*Dr. Payne.*) Do you know anything as to the evidence in regard to the existence of tuberculous disease in poultry?—Yes, I have seen a large number of examples in the Brown Institute.

1630. And you regard that disease as the same as that in the human or bovine species?—Yes.

1631. Is tuberculosis among poultry very prevalent?—Yes, in London it is.

1632. When it occurs, does it occur in a good many organs?—Very often it does, but the most common seats are the throat, the mouth, and the gullet. Exactly the same state of disease has been seen by various others who have made feeding experiments on animals; calves, for example, have been found similarly infected.

1633. Does the disease occur in the liver?—Oh, yes, it appears in the liver.

1634. But not often in the meat or muscles?—That I cannot say.

1635. But at all events the consumption of the liver may be a source of danger?—Unquestionably, there is one point in regard to the meat of fowls which I may mention and which you will find in the evidence before the departmental committee. The only case I know of bearing upon the prevalence of the virus in the flesh of fowls was given in Mr. Lingard's evidence respecting a well-known case which occurred in France. It was a case of phthisis—of ordinary lung phthisis, which appears to have broken out in a village. The fowls belonging to a particular person, who had died of consumption, were sold to another person who had been recommended to eat raw meat. She ate the flesh of these fowls and became consumptive. Ultimately she died of tuberculosis, and it was subsequently found that the fowls had been infected with that disease also. That has always been quoted as a case of the transference of the disease from fowls to man. It is the only case I know of in which the flesh of fowls has been said to be virulent.

1636. Is the tubercle ever found in the marrow of the bones ?—Oh, yes ; very often.

1637. And, of course, in the liver ?—Yes, very often.

1638. As to the internal parts of a fowl which are used as food, may they be a source of danger ?—Yes, certainly.

1639. (*Prof. Brown.*) You said, Professor Horsley, that you had known a blow on a joint to cause the development of tuberculosis ?—Yes, in many cases.

1640. The *bacilli* had probably remained dormant for some time ?—Yes.

1641. Am I to conclude that the skin was not in any way broken ?—Yes, of course.

1642. In carrying out experiments as to the probable injurious effect of feeding animals with tuberculous meat, you suggest the pig as a desirable subject to experiment upon ?—Yes.

1643. Would you consider experiments upon the pig, or any of the lower animals, satisfactory in relation to the possible effect of the same kind of food on the human subject ?—Yes, I would.

1644–7. I ask the question because several witnesses have told us they would not ?—I daresay there are persons who would not consider the two cases at all parallel.

1648. In fact, one witness suggested that the only way to obtain satisfactory evidence was to get permission from the Government to make use of criminals for the purpose ?—Yes.

1649. Suppose that were possible, do you not consider that it would be difficult in the first place to determine whether the criminals to be experimented upon were free from tuberculosis themselves ?—I might do so.

1650. And supposing that the thing were feasible, which practically it is not, can you form any idea of the number of experiments that would be necessary ?—Of course a very large number would have to be made, which would render it impossible that such experiments could be carried out.

1651. A considerable number of experiments would be necessary before any conclusion at all could be arrived at ?—Yes.

1652. Bearing in mind that human beings are frequently infected with the disease ?—Yes.

1653. I did not quite understand your reference to meat in which you had seen a tuberculous deposit in the muscle. Is it the case that where you have such meat in which there were no evidences to the eye of the presence of tubercle, but which meat came from an animal known to be tuberculous, would you regard it as dangerous as that in which you could see the tubercle ?—No, I should not look upon it as being so dangerous, but, in my opinion, it would be sufficiently dangerous to insist upon the destruction of the carcase.

1654. But suppose that you examined portions of the meat close to the tuberculous deposit, a portion of the diaphragm for example, after taking off the skin and the peritoneum, and found no further trace of tuberculosis, would you look upon that meat as dangerous ?—Unquestionably. I should not consider that the carcase had been sufficiently examined unless it were tested in the following way. The diaphragm should be taken, squeezed, and the juice expressed for inoculating experiments. I do not mean ingestion experiments, but inoculation.

1655. In reference to the case of the fowls, do you know if they were eaten raw ?—Yes ; that was the object of the woman who had them ; she had been directed to eat them raw.

1656. (*Chairman.*) May I be allowed to interpolate a question which would, perhaps, have come in better before Professor Horsley's last answer. (*To Witness*) Have you any evidence as to the possibility of doing anything satisfactory, owing to the enormous number of carcases which come over here already slaughtered ?—As regards their examination, do you mean ?

1657. Yes ?—Well, I take it that the public have to run a certain amount of risk in connection with the carcases which come over here in a frozen state and have to be examined with the naked eye, especially as they are all stripped. There would be a certain amount of risk unquestionably.

1658. The risk would be in proportion to the whole number of carcases sent over as compared with those which can be more satisfactorily examined ?—Yes.

1659. (*Prof. Brown.*) Returning to the question of tuberculosis in poultry, does it occur to you that there would be almost as much danger from the consumption of tuberculous fowls as there would be from the consumption of tuberculous cattle ?—Certainly ; I think there would be quite as much danger, if not more.

1660. Do you happen to know whether the lungs of fowls are frequently infected with tuberculosis ?—Not so much as the alimentary tract.

1661. I asked the question because there are an enormous number of *bacilli* found in the liver and other internal organs of a fowl which are considered bits for an epicure ?—I think that all the tissues of a fowl are affected to a greater or a less degree, but one sees the tubercle most in the alimentary tract.

1662. Is it the case that the liver of the fowl, which is constantly infected, is nearly always eaten ?—Yes.

1663. May I ask if you know the terms of the reference to us ?—No ; I am ashamed to say that I do not.

1664. I will ask Mr. Hudson, the Secretary, to read them to you ?—I shall be glad to hear them.

The Secretary read the terms of reference to the Commission as follow :—" Whereas We have deemed " it expedient that a Commission should forthwith " issue to inquire and report what is the effect, if " any, of food derived from tuberculous animals on " human health ; and if prejudicial, what are the " circumstances and conditions with regard to the " tuberculosis in the animal which produce that effect " upon man."

1665. (*Professor Brown to Witness.*) What I want to ask you is this : is it within your great practical knowledge and experience of laboratory work, and the opportunities you have had of studying the literature on the subject, to give the Commission any advice as to the proper mode of procedure with a view to our being able to report on that reference ? Up to the present time I think I am correct in saying that we have not had a single fact which will enable us to answer that question.

(*Chairman.*) Professor Horsley has used the term "highly dangerous" several times.

(*Witness.*) Yes. As far as I understand the reference, it seems to convey to me that information is required as to whether the food derived from tuberculous animals is invariably infective, and, if so, then I understand the reference to mean what effect will the condition of tuberculosis in animals consumed by human beings have upon mankind ? Am I further to understand that the Commission will also take into consideration the procedure to be adopted in the way of preventive legislation ?

(*Chairman.*) Oh, no.

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1666. (*Professor Sanderson.*) Does it occur to you that there is any question of special importance which you think requires investigation ? Has any such question occurred to you ?—Being in possession, as we are, of certain facts ?

1667. We want to know, first of all, that there is or is not a risk ?—Yes, certainly there is.

1668. Secondly, we want to know how great that risk is ?—I quite understand.

1669. Is there any line of investigation that occurs to you as likely to be of use ?—First of all, I think there is a risk ; secondly, I consider that the risk is so considerable as to require legislation ; and I do not see, from the facts already ascertained by research, that any contrary opinion can be formed upon the statements which have been made or the evidence ; nor do I see that future research will throw much more light upon the question.

1670. Do you consider that the results which have already been obtained by investigation are conclusive in showing that the meat of an animal having tuberculous disease of any kind, although that meat may not present any appearance of disease, is attended with danger if it is consumed by a human being ?—Yes, certainly.

1671. Can you state generally what ground exists for that opinion, looking at it from the side of pathology ?—The opinion is chiefly based upon the experiments which go to show that milk or meat contains in a certain proportion of cases the infective virus of tuberculosis.

1672. You mean the bacilli ?—Yes, bacilli ; that is that it is impossible to say absolutely whether the virus is present or not, and that, therefore, the whole of the meat ought to be destroyed. The same holds, of course, in regard to the milk.

1673. Yes ; but if the risk is extremely small, do you think we should be justified in holding the opinion that it should be destroyed ?—As regards the proportionate risk, that has been stated very differently by different investigators who have worked at the subject ; there is the particular method I referred to just now, namely, that of taking a considerable quantity of tuberculous meat, and expressing the juice so as to give the experiment every chance of succeeding. It has only been performed in a few instances. If, therefore, it is contemplated that any further research or experiments should be made, it would be worth while to encourage investigation in that direction, and if that method of research has not been duly performed, to see whether it gives the negative to some of the results which have been published. The results of some of Nocard's experiments are possibly explained in that manner and, to my mind, the fact of such negative experiments existing goes to show that the risk is always proportionate, and such results, consequently, should not be taken as absolute. Further, I think that the conclusions so arrived at should not be taken as the basis of any recommendation by the Commission. I think still that the Commission should recommend that all the food in question should be destroyed.

1674. Are there no general grounds for thinking that the meat of an animal which has tuberculosis in certain organs is likely to be dangerous in its consumption ?—Well, I think certainly that there are such grounds. The particular tissue upon which the tubercular virus seems to grow with the greatest facility is the lymphatic tissue. As that pervades the whole body, I think the risk of its being universally infected is very strong.

1675. I think you expressed an opinion, formerly, that it would be justifiable and expedient, not only to regard the meat of a diseased animal as a source of danger, but the existence of tuberculosis among animals as a source of danger to man ?—Yes ; I think, myself, that that is by far the larger question. I am of opinion, very strongly, that the point is one which should be taken up at once by the Government.

1676. What point do you mean ?—The fact of the present existence of tuberculous animals.

1677. (*Professor Sanderson.*) On scientific grounds do you think that that would be possible ? Do you see no difficulty in making a diagnosis of the disease in animals in the earlier stages with the present modes of diagnosis which are at our disposal ?—With regard to the presence of the disease in living animals as contrasted with dead meat, there is undoubtedly, of course, an extra difficulty in arriving at a determination ; but I do not think, especially with our latest knowledge, that the difficulty is overwhelming. The method of investigating the condition of an animal among living stock has hitherto been by physical examination, by auscultation, percussion, and so on. That method is, admittedly, imperfect in the hands of a veterinary surgeon, and as a diagnosis is confessedly impossible under the circumstances, it becomes imperatively necessary to adopt some other plan. I believe there are two other plans which might be carried out by any veterinary surgeon in a country district. One of those plans is interfered with by present legislation, but that, of course, could be provided for. The first plan is, that the veterinary surgeon should collect the mucus, as recommended by a French surgeon, after the animal had been suitably gagged, to prevent its biting, it should be collected from the pharynx and larynx, and the animal made to cough by pressing the larynx, if possible. The mucus so collected could be sent to a skilled bacteriologist for examination. The mucus should then be inoculated into rodents, rabbits or guinea pigs. The next plan is that the veterinary surgeons should be provided by the Agricultural Department with the so-called lymph of Dr. Koch, and, of course, accustomed as they are to take temperature observations, it would be easy for them to ascertain the result of the experiment. That, to my mind, is the easiest plan of performing an investigation in this country ; and, moreover, I think it would be a useful plan for investigating the condition of pedigree animals, the destruction of which involves a serious loss.

1678. You think in short that there is a prospect at some distant period of being able to improve the diagnosis of the disease in animals and to bring it to much greater perfection than at present ?—Yes, I think we have that knowledge now.

1679. (*Chairman.*) The experiment of inoculating rodents has been made ?—Yes.

1680. (*Dr. Payne.*) How long would it take to get at the result of inoculating experiments upon rodents ?—If you wished to have a speedy opinion, I think that within a fortnight you could ascertain the result, if you killed the inoculated rodent and made a *post-mortem* examination.

1681. I take it your view is, that if it is justifiable to slaughter animals infected with cattle plague or pleuro-pneumonia in order to prevent loss to the owners of other animals by the spread of disease, it is still more justifiable to destroy tuberculous animals in order to prevent them from infecting mankind with that disease ?—Certainly ; and other animals also, because it is a disease which infects not only human individuals but those lower animals which may be brought in contact with the diseased stock. And then there is the additional danger of hereditary disease which is strongly marked in the case of tuberculosis. I think that if compensation were awarded there should be no difficulty in carrying out legislation.

1682. Would there not be a difficulty in the extent of the subjects which would have to be dealt with ?—That is a practical point, namely, whether the country would be prepared to bear the loss of stamping out the disease. Of course it would have to bear some loss.

1683. I suppose the country would bear the loss incurred in stamping out the disease, supposing that the advantage was in proportion to the risk run from the spread of the disease ? That is the very question we have to deal with ?—Yes, and I say that the risk is very great ; I should like to add a word as to the

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known extent of the disease. We are in possession of a large number of facts and figures, and they all go to show that among cattle, as among human beings, the disease has not become absolutely generalised, but there are some districts in which it is more prevalent than in others. I know the roughness of such statistics, but they go to show that where regular examination of all slaughtered cattle has been adopted, the proportion of disease has not been so high as would create a panic, supposing the proposal of stamping it out were put into effect. The disease has only been in many cases from 5 and 10 to 20 per cent., and I suppose that if it were as high as 4 or 5 per cent., it need not necessarily frighten the country.

1684. (*Prof. B. Sanderson.*) Is there any country where the stamping-out of tuberculosis is now carried out?—None that I know of.

1685. (*Chairman.*) Is it your opinion that the stamping-out of tuberculosis would only imply the destruction of something like five per cent. of the animals of the kingdom?—I think so.

1686. What about hens and chickens?—There I have no data to go upon.

1687. What good would it be to kill the cattle, if fowls and chickens remain to distribute the disease?—It would diminish the chance of infection. The disease in a chicken does not arise in the same way, and it runs a far more rapid course than in a beast. Then, again, when tuberculosis first makes its appearance in a hen-house, it soon becomes considerable, and the owner at once recognises the fact that he must destroy the stock. That is a common experience, I think, among fowl-keepers.

1688. After you have stamped out all signs of disease in chickens and cattle, there would still remain a certain number of pigs and sheep, and after that there would still be the risk of an outbreak from infection by foreign cattle?—I believe I must have conveyed a false impression. I think that the importation of diseased meat could be controlled. If a carcase looked suspicious, and had obviously been closely stripped—a little piece having been cut away here and there—I think that carcase ought to be impounded and destroyed. The inoculation test would hold good in such a case, the frozen meat being readily detained for experimental investigation. I certainly think that all dead meat should be subjected to the most rigid inspection.

1689. Passing from that matter for a moment, do you agree with the last witness we had before us that the extent to which tuberculosis prevails among animals, and the possibility of its communicability to man have been revelations of the last few years?—I think there is no doubt that a large number of people were ignorant of the fact that they could contract tuberculosis just as pathologists were in ignorance of its being an infective disease until experiments on animals proved the fact.

1690. But it has existed for a very long period?—Quite so.

1691. Is it your opinion that the prevalence of consumption is due, to any appreciable extent, to the existence of the disease in animals and poultry?—Yes, I believe it is.

1692. And that the stamping out of the disease in them would produce a perceptible diminution of consumption in man?—Unquestionably it would do so, especially among children.

1693. You rely there practically upon the tuberculous milk which is given as food?—Yes; and the meat too.

1694. Why should children be more poisoned than grown up people?—The resistance of a child is lower than that of an adult, and then children are frequently given raw meat as an article of diet. But the first reason is quite sufficient to account for the greater prevalence of the disease among children—I mean the lesser power of resistance.

1695. How would you define a child?—I should say until it reaches puberty.

1696. It is then more liable to consumption?—Yes, and to other forms of tuberculous disease.

1697. That does not proceed from eating tuberculous meat?—There are constantly occurring varieties among cases, for example, children suffer from *tabes mesenterica* which hardly ever occurs in the case of an adult. The same remark applies to a certain extent to peritonitis.

1698. (*Prof. Sanderson.*) Is it more easy to communicate the disease by feeding to young children than to adults?—I was speaking generally of their lesser power of resistance to an infectious disease as compared with an adult.

The witness withdrew.

Inquiry adjourned until Monday, December 15th, at 12 noon.

TWELFTH MEETING.

7, Whitehall Place, S.W., Monday, December 15th, 1890.

PRESENT:

THE RIGHT HON. THE LORD BASING PRESIDING.

Dr. J. F. PAYNE. | Professor G. T. BROWN, C.B.

Mr. LEOPOLD HUDSON, *Secretary.*

Mr. E. Watson.

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Mr. EDWARD WATSON, President of the Glasgow United Fleshers' Society, Member of the County Council for Lanarkshire, and partner in the firm of Robertson and Johnston, cattle salesmen, Glasgow, called in and examined.

1699. (*Chairman.*) You have come here, Mr. Watson, I believe, to represent the cattle interest and a considerable number of tradesmen of Glasgow?—Yes, my lord.

1700. You are conversant, I take it, with the fleshers' trade of Glasgow generally?—Yes, it is the only business I have been practically engaged in.

1701. Have you been engaged in it for many years?—Yes, for something like 26 years.

1702. You are president of the United Fleshers Society of Glasgow?—Yes, and my business is one of the most extensive in Glasgow.

1703. And you understand the duties and responsibilities?—Yes.

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1704. You are also a member of the County Council of Lanarkshire?—Yes, I am.

1705. You are aware, no doubt, that the object of this particular Commission is of an important character?—So I understand from the circular I have received.

1706. You have seen what it is we have to inquire about?—Yes.

1707. Namely, the effect which the consumption of food from tuberculous animals may have upon human health?—Yes.

1708. Of course, it is a very interesting and somewhat difficult matter, but I do not know whether it is our duty to enter into the question, which I suppose is a burning one in Glasgow and Edinburgh, whether the medical officers of health have taken exaggerated views of the matter. Do you think they have?—That is certainly our opinion.

1709. Have you anything to place before the Commission to show that the medical or sanitary authorities in Glasgow have gone beyond what was reasonable or proper in condemning as food for human consumption the use of flesh from tuberculous animals?—Yes, my lord, we think they have gone beyond their ordinary and proper duty.

1710. In what way?—In so far as they condemn animals, although only slightly infected with tuberculosis. In that respect we are of opinion that they have exceeded their duty. If it can be shown that an animal is really infected with the disease so as to render the flesh from it injurious to human health, we quite admit the reasonableness of the contention that the carcases of such animals should be destroyed and should not be exposed for sale, but as long as the diseased condition of the animal is an open question, we think it is most unfair to the butchers to condemn, without compensation, an animal which he has bought in perfectly good faith, and all the more so that it has never been demonstrated that the use of the meat under such conditions has ever been prejudicial to human health.

1711. You say that it has never been demonstrated to you that the use of meat from an animal in such conditions is prejudicial to human health?—Yes.

1712. Have you had experience long enough to enable you to say whether any infection has ever been contracted from the use of meat exposed in Glasgow?—I do not think it has ever been proved.

1713. If it had occurred, would you have heard of it or have become acquainted with it?—Certainly I would; at the same time, I believe that had it been proved beyond a doubt that this flesh was hurtful, this Commission would not have been in existence.

1714. Flesh sold for human consumption?—Yes, I speak of cases in which flesh apparently healthy and well-nourished may have come from a tuberculous animal, an animal which was very slightly infected with tuberculosis.

1715. Your expression "very slightly" is rather ambiguous. May I ask you to explain what it is that you mean?—I mean an animal with a slight infection.

1716. Can you not define "very slightly" rather more clearly? Are we to take it as describing the appearance of the flesh to the ordinary eye when exposed in the butcher's shop for sale; that it would not in such a case be meat that would be subject to condemnation by the sanitary inspector?—I do not exactly follow your question.

1717. You would not deny, I suppose, that if meat were obviously infected with tubercles, it would be unfit for human consumption?—Certainly not; I would say at once that it would be unfit for human consumption.

1718. Unfit for human food?—Yes.

1719. Then where would you draw the distinction when you say "very slightly"? Do you say that meat exposed for sale which may not have been condemned by the sanitary inspector, but which nevertheless came from a tuberculous animal would be fit for human food; that there would be no danger in retailing it for consumption? Do you say that?—Yes, what I say is that in the case of an animal slightly infected with tuberculosis, with an eruption in the membrane, say, of the size of one's hand, if the parts found to have been infected had been excised, the danger is altogether removed.

1720. Does not that amount to very much what I say, that if the flesh generally is not affected, and the only parts which show signs of disease are cut away, the danger is very slight, or none at all?—That is my opinion.

1721. Then does it not come to this: that the evidence of the existence of tuberculosis is only to be ascertained at the place of slaughter?—I think that it can be ascertained there with greater certainty than afterwards.

1722. What do you say in a case where the signs of disease are so bad as to be easily ascertained on the inspection of the meat?—In that case I say that it ought to be condemned.

1723. What is the condition of the flesh which, as a matter of ordinary practice, is condemned by the sanitary authority?—I have seen the flesh of a very fine ox condemned, because there were signs of a very slight infection of tuberculosis, or what was said to be tuberculosis. I have also seen the flesh of an animal allowed to be consumed which came from an undoubtedly tuberculous animal, in which the flesh was pale, watery, and generally in a flabby condition, but where the visible evidence of the disease had been removed. I have also seen cases where I would have defied any medical authority from the appearance of the flesh to say that the ox from which it came had been suffering from tuberculosis, or to have detected the existence of tuberculosis in the meat itself, but which was said to have been tuberculous.

1724. Does not that come to the distinction which I have been endeavouring to put, that tuberculosis which shows itself in the wasting away of the animal or tuberculosis that is obviously existing in the meat is in a different category from meat which upon inspection you could not say came from a tuberculous animal, unless you were present at the slaughter?—Yes.

1725. Are these two distinctions fairly in your mind?—Yes, undoubtedly.

1726. Do the inspectors go into the butchers' shops, or do they confine their operations to the slaughter-house?—They confine their operations to the slaughter-house and public meat market.

1727. Does no inspection of the butchers' shops take place?—I have never had a policeman or inspector within my place; and I do not know that it is the custom in Glasgow to go into the butchers' shops, unless there is reason to suspect that something has been taken there outside the ordinary course of business, in which case, of course, the police would interfere.

1728. Then the action of the inspector takes place naturally from the examination of the carcase before it has been cut up?—Exactly. I may tell you that the custom in Glasgow is somewhat different from the custom in London. Nearly all the meat cut up for sale in Glasgow is that of animals slaughtered in Glasgow, and for that reason the inspector, on visiting the slaughter-houses, has every opportunity of examining an animal when disembowelled.

1729. I am not sure, but I think that a great deal of meat has been condemned in Smithfield when it has been exposed for sale?—I believe so.

1730. Is that a different case from yours?—Yes; in the case of Smithfield a very large quantity of dead meat is sent from various parts of the country, and there is no slaughtering there.

1731. No matter how that is, the fact remains that the inspector in London operates in the market itself, but in Glasgow only in the slaughter-houses?—Carcases are all inspected in the slaughter-houses, and also all meat taken to the public dead meat market, and sold there.

1732. Sold in the butchers' shops?—No, in the Corporation's meat market.

1733. Those are the carcases cut up into joints?—Yes, and also sold in carcases and in parts of carcases.

1734. Would you go as far as to say that if the inspector in the meat market is unable to detect anything like an unhealthy condition in the joints and pieces of meat exposed for sale, that would, *primâ facie*, be evidence that it was not injurious to health, even if it came from a tuberculous animal?—No, my lord; if there is the slightest suspicion of disease, even if a small joint shows evidence that it came from an animal which had been suffering from tuberculosis the inspector would condemn it.

1735. That is very much what I put to you just now. Would you contend that if the inspector, on going through the market and seeing the meat exposed for sale, is unable to detect that this or the other joint has come from an animal that was suffering from tuberculosis he ought not to condemn it as injurious to health, even if, on going back to the slaughter-house, he might find evidence to show that some portions of the animal from which it came showed signs of the disease?—I think it ought to be condemned if there was the slightest suspicion that the meat was unwholesome.

1736. But if the inspector, on seeing the meat exposed for sale, cannot detect that it came from a tuberculous animal, do you say that it ought not to be condemned; is that your view?—It is my view that if it is well nourished and there is nothing to show that it is not good meat it ought not to be condemned; but if it shows signs of being unhealthy, then it should be thoroughly examined before it is allowed to go into consumption as human food.

1737. Have your society taken any pains to ascertain, as a matter of fact, that disease has ever been spread by the use of tuberculous meat as food?—They have never taken any pains to do that. We have no idea whether it is so or not. We are unable to say whether disease has been spread by the consumption of tuberculous meat; we have not the slightest idea.

1738. Have you any opinion upon the matter?—Personally, I have no opinion.

1739. But you contend that the flesh should not be interfered with if its appearance is wholesome?—That is my opinion. Whether it may be dangerous when used as human food I am not in a position to say; but judging from the condition and quality of the flesh of the animal, and seeing that it has been only slightly infected, I say that it might be used for food if there is nothing to show to the contrary.

1740. If the tuberculosis in the animal is excessive, if the animal shows signs of wasting and of being altogether out of condition, I suppose that it would appear on the colour and quality of the meat?—Yes, and would show in the general unhealthiness of the animal when alive.

1741. Is there much meat of that inferior quality, meat that is obviously not worth a high market price, brought into the market at Glasgow for sale to the poorer classes at a low price?—There is not much now. But prior to the case of Mr. Hugh Couper there was a very large quantity of it. The result of that case and of the measures which have since been taken by the authorities has been to cut off that inferior source of supply and to prevent an objectionable class of meat from being sent into the market.

1742. Is it under the Public Health Act that the condemnation of this kind of meat has taken place?—Yes, the condemnation has taken place under the Public Health and Police Acts.

1743. I suppose that the primary function of the inspector who condemns the meat or inspects it is to put aside putrid or overkept meat?—That is what he was originally appointed for.

1744. And obviously diseased meat would fairly be brought under that category?—Certainly.

1745. But your contention is that meat not obviously diseased and which has not been proved to be injurious to health has been condemned?—Yes.

1746. You complain of that having been the case, and say that it has been injurious to your trade?—Yes; but I ought to add that since the appointment of this Commission the regulations have not been quite so stringent as they were previously.

1747. Since the appointment of this Commission?—Yes.

1748. The regulations have been relaxed?—Yes.

1749. Can you, from your experience as a practical man, point out any particular class of animals which you would allow to be properly the subjects of confiscation?—No. I think that each case requires to be considered entirely on its own merits.

1750. Is there a great quantity of foreign meat imported into Glasgow?—Yes. With your permission I will state what the importation has been, as I have taken some notes of it. The change of practice which took place at Glasgow, consequent on the success of the prosecution of Mr. Couper has been attended with great pecuniary loss to the trade in Glasgow. Between the 15th of May, 1889, and the 15th of May, 1890, 315 cattle, of the value of from 12*l.* to 22*l.* each, were wholly condemned in the slaughter-houses in Glasgow, on account of tuberculosis, representing a total loss of 5,355*l.* to the butcher; and but for the change in the practice the greater part of the meat condemned would have been passed as perfectly wholesome and fit for human food.

1751. You consider that the old practice ought to have remained in force, on the ground that it was the correct practice. Is that your contention?—I do not quite understand.

1752. You think there was no justification for departing from that practice?—My contention is that these 315 animals would not have been condemned, or at any rate the greater part of them.

1753. You say that but for the change of practice the greater part of the meat condemned would have been passed as perfectly wholesome and fit for human food?—Yes.

1754. And you say that it was not only the old practice, but that it ought to be the practice now?—I do not say that it was exactly the old practice.

1755. You say in the paper you have handed in to the Commission that the change of practice represents a total loss of 5,355*l.* to the butchers between May 1889 and May 1890?—Yes.

1756. And you go on to say "but for the change of "practice the greater part of the meat condemned "would have been passed as perfectly wholesome and "fit for food." I understand you to refer there to "the old practice?—Yes, the great part of the carcases of the 315 cattle would have been passed, and only the infected portions condemned.

1757. Then do you contend that there is no justification for changing the old practice?—My lord, I could not answer that question without having before me each individual case to which it applies. I did not see the 315 animals which were condemned, I have simply taken the figures from the reports of the market authorities.

1758. I am only assuming that your proposition is a true one, that but for the change of practice this large quantity of meat would have been passed as wholesome and fit for human food?—It would have been so passed, with possibly a few exceptions.

1759. Then is it your opinion that there has been no public justification for departing from that practice?—I do not say that in regard to the whole of the 315 animals. I am quite ready to admit that there may have been some animals among the 315 which I, personally, would not have passed.

1760. But which would have been passed by the inspectors?—Yes, if the previous custom had been observed.

1761. You say that since the greater rigour of the inspection the number of animals brought into Glasgow for slaughter has been diminished?—Yes, very considerably. I should say by about one half.

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1762. Do you mean one half of the total amount of meat brought into the market or only one half of the animals which were formerly slaughtered ?—I mean the animals brought in for slaughter.

1763–4. What is the nature of the supply which has been cut off? Is it, in your opinion, the supply of tuberculous animals ?—There has been a material decrease in the number of stock sent in for slaughter. The result of the trial to which I have referred was that the senders found they were running such serious risks by sending their cattle to Glasgow that they now send them elsewhere.

1765. I want to follow up your previous statement. I understand you to say that since the more rigorous application of the law or practice the supply of live animals into Glasgow has considerably diminished ?—Yes, it has.

1766. Is it your opinion that the animals which have been thus withheld from slaughter are animals suffering from tuberculosis, or animals of an inferior quality ?—All classes are withheld, but particularly inferior animals.

1767. Both ?—Yes.

1768. Then am I to take it that the more rigorous examination and condemnation of flesh of this kind has produced a better supply of home-bred meat, or rather has it been the cause of withdrawing from consumption a large quantity of inferior meat; is that so ?—Yes, but it should be kept in view that inferior animals which formerly used to be sent to Glasgow, are now slaughtered in the country, where there is no inspection, and the dead meat only sent into the towns, where all traces of disease have been excised.

1769. Do you consider that that is a matter of complaint or objection, or a thing that we should be rather glad of ?—It is a thing that we should rather be glad of, and it is not against the withdrawal of meat of an inferior quality or diseased meat that we have any complaint to make. I do not appear here to-day to object to the more rigorous regulations on that account, but to the wholesale condemnation of carcases the greater part of which shows no signs of disease.

1770. Then I conclude that you are in favour of the reasonably rigorous inspection of the animals brought in for slaughter ?—Yes; the butchers greatly desire a rigorous inspection of the live animals in the public market, and the Glasgow butchers have petitioned the local authority to provide for such inspection, but the local authority objected on the ground that they might thereby be held to guarantee the soundness of all the animals in the market.

1771. Let me now go to the other point. You say that in consequence of the smaller supply of animals for slaughter from the interior of the country there has been a much larger importation of carcases from abroad ?—Yes.

1772. What do you say in regard to the carcases imported; are they absolutely free from inspection in regard to their having come from tuberculous animals? —I do not refer to carcases at all, but with live animals.

1773. But part of your case, and part of the criterion which you apply to home grown animals, is that they have been supplanted by carcases imported from abroad ?—Yes.

1774. And you say that the same rigorous inspection cannot be applied in the case of carcases brought in from abroad ?—No, it cannot.

1775. You do not think that that is fair to the home producer ?—I do not think it is fair.

1776. As a matter of fact, is it possible, except in the case of a very advanced state of disease, in which case the animal would not be sent over to this country, to detect whether there has been tuberculosis or not ? —No.

1777. In such a case you say that the opportunity is lost of seeing whether the animals from which the carcases came were tuberculous or otherwise ?—I think it would be very difficult in any case to tell from dressed carcases what the original condition of the animals was, or whether they were infected with tuberculosis or not.

1778. It would be difficult to tell from a dressed carcase ?—Yes, from a dressed carcase.

1779. I observe that most of what you have told the Commission is very well stated in the paper which I have before me. Your views are very well put before us in the paper. I do not understand, however, that your society takes any pains, or goes to any expense, with a view of ascertaining whether the disease of consumption has originated in any way from the use of infected meat ?—No, the society has taken no pains whatever in that direction. We regard it as the duty of the Government to make an exhaustive and satisfactory inquiry into that.

1780. Then, I suppose, that you would rather not give an opinion upon that subject ?—I have no opinion on the subject to give. We think it very hard, though, that these stringent rules should only be applied to our commodities—beef and mutton—when rabbits and poultry pass free, although they are much more susceptible to the disease of tuberculosis, than cattle and sheep. I was talking the other day with Mr. Sheriff Berry at a dinner party in Glasgow, and he told me that a friend of his in the country always examined the rabbits that are killed for his own table, and that a great number are thrown away on account of being infected with tuberculosis.

1781. We have been told that the same is the case with poultry ?—Yes, I know it is.

1782. Is it the same in the case of sheep ?—I have seen tuberculosis in sheep. One of the greatest developments of tuberculosis I ever saw was in the carcase of a sheep. It was a sheep which had been fed upon Goat Fell in the island of Arran. How it contracted the disease I have no idea, but certainly the tubercle was very strongly developed in it.

1783. Have you any evidence to give us as to other facts ?—No; but I think that when butchers buy animals in the market in perfectly good faith, and the animals themselves give no indication of any disease whatever, but, after being slaughtered, they are found to have been slightly infected with tuberculosis the buyer ought to be compensated in some way or other, if the animals under such circumstances are condemned. It is not fair as it were to take their money out of their pocket, and make the entire loss fall upon them.

1784. If an animal is well nourished, as an ox should be for consumption, and there was no indication of disease to induce anyone to suppose that the joints of meat when cut up would not be consumable, and if the carcase generally, was good and free from any appearance of tubercle, you think that it ought not to be condemned without compensating the butcher who slaughtered it ? Is that what you say ? —Yes.

1785. Although there might be some appearance of tubercle in the lungs or in some other part of the internal organs not exposed for sale ?—Yes.

1786. I suppose that when tuberculosis has proceeded a certain length, the emaciated or wasted condition of the animal would proclaim pretty clearly that it was in a tuberculous state ?—Quite so.

1787. You would not propose to compensate anybody for the slaughter of an animal in such a condition ? —No. I may say that we made a proposition to the corporation of Glasgow to this effect; that we thought it only reasonable and fair and in the interests of the butchers and of the public that they should appoint inspectors to inspect all the animals that went into the Glasgow public market, and if there was the slightest suspicion that they were infected with this disease, that they should then be set aside and slaughtered instead of being allowed to go into the market and be sold as sound. But if it were found that some of the animals passed as sound were diseased, and the disease was only discovered after the animal was slaughtered, then our proposal was that in the event of the animal being condemned the owner should be compensated.

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1788. I may as well tell you that the question of compensation forms no portion of our inquiry, although it may be an important one for future consideration. At present the only point which concerns us is the possibility of the spread of consumption among human beings by the use of infected meat as an article of food. That is the only point in which we are interested and we do not care how many diseased animals may be slaughtered. There is, however, one thing to which I should like to call your attention. It is a matter which is referred to in your statement which I have before me, namely, the serious falling off in the number of cattle slaughtered in the Glasgow slaughterhouses. The decrease appears to have been rather startling ?—Yes.

1789. You say that in 1887–88 the number slaughtered was 61,050, of which about seven-eighths were home-bred cattle ?—Yes.

1790. But you go on to say that in 1889–90 the number slaughtered fell to 31,005 ?—Yes, that was so.

1791. About one half less home cattle have been slaughtered this year, 1890, than were slaughtered in 1888 ?—Yes.

1792. And you add that the falling off was coincident with a great increase in the importation of Canadian and United States cattle ?—Quite true.

1793. The figures you give are quite startling. I will not trouble you with going over them, unless you wish that I should do so, but I should like some notice to be taken of them, because they are of importance to the agricultural interests of this country ?—All the facts mentioned there are perfectly reliable.

1794. (*Dr. Payne.*) I should like to put one question to you, Mr. Watson. I understood you to say that the meat of animals which have had general tuberculosis, or have been largely affected with tuberculosis, is always bad in appearance ?—Yes, generally ; and there is no difficulty in saying that the meat is unwholesome.

1795. May I ask if you would recognise it having come from a tuberculous animal, or would you only say that it came from an animal which was not in good health ?—I do not know whether I should be able to get many to bear me out in my opinion, but I have certainly formed an opinion that if an animal has had a well developed infection of tuberculosis, it is always possible to tell from the appearance of the flesh. I think that in five out of six cases I should be able to detect the existence of the disease from the condition of the flesh.

1796. Is there no other disease which produces exactly the same alteration in the flesh ?—No ; the same appearance cannot be set up by any other disease that I am aware of.

1797. But there are, of course, other diseases which attack cattle which make the meat bad in appearance ; Is not that so ?—Yes, foot-and-mouth disease, for instance. Animals suffering from foot-and mouth disease present a peculiar appearance in the flesh, but there is no similarity between the two appearances.

1798. No similarity between the appearance which the flesh of an animal presents if suffering from tuberculosis, and if attacked by foot-and-mouth disease ?—No.

1799. What would you say with regard to pleuro-pneumonia ?—I cannot speak so clearly in regard to that disease.

1800. Does pleuro-pneumonia necessarily affect the appearance of the meat ?—Yes, I think it must. My opinion is that fever or any increase in the temperature of an animal must affect the flesh.

1801. It would affect it in such a way as to enable it to be easily recognised as being bad ?—I think so. It would be recognised as not being of a natural colour.

1802. (*Chairman.*) In the paper you have placed before us, you call attention to some important facts, and you complain of the detrimental effect which the change of practice, of which you complain, in Glasgow has had upon the agricultural interests of the country during the two years that the change of practice has been brought about ?—Yes.

1803. You say that "about one half less home " cattle were slaughtered in Glasgow in 1890 than " were slaughtered in 1888, a falling off which was " coincident with the great increase which took place " in the importation of Canadian and United States " cattle " ?—Yes.

1804. You go on to say, " In 1888 the number of " cattle brought from Canada to the Clyde was " 21,959, whereas in 1889 the number was 28,309, " and in 1890 the number was 39,563. In 1888, " 13,083 cattle were brought to the Clyde from the " United States, whereas in 1889 the number was " 31,420, and in 1890 the number was 39,413 " ?—Those figures are quite correct.

1805. The increase this year in the number of cattle imported from the United States for consumption in Glasgow was from 31,420 in 1889 to 39,413 this year ?—Yes.

1806. And you say that, in regard to this meat, there has been no means of showing that the animals from which it was derived were free from tuberculosis at the time they were slaughtered ?—I think you must have misunderstood me, my lord. In the paper you have before you I refer only to the shipments of live stock. I have taken no note of the increased or diminished importations of dead meat ; what I speak of is live animals.

1807. Then the live animals sent in from Canada and the United States would be subject to inspection in the same way as home-bred animals ?—Yes.

1808. Can you say anything as to the number of animals sent over in carcases ?—No. Perhaps I may be permitted to refer to a case which came under my own observation five or six weeks after the Couper trial in Glasgow last year. In the Couper case an animal which had a very slight eruption on the diaphragm and upon the lining of the body was condemned, after slaughter. About five or six weeks after the carcase of a bullock from the United States, but slaughtered in Glasgow, was brought to my shop which had exactly the same appearance that Mr. Couper's had, only to a somewhat less extent. My curiosity was aroused, and I wondered what the cause could be of the peculiar eruption I noticed. I cut the part out and, on examination, I found that what had caused the eruption and appearance was a broken rib. In every way, as far as the naked eye could determine, the appearances were exactly the same in the bullock belonging to Mr. Couper and the bullock from the United States. The sole cause in the latter case was a broken rib.

1809. Then is it one of your contentions that mischief may be done by a hasty or superficial examination ?—Yes ; and I believe that in the case of Mr. Couper's bullock there was a hasty examination and an important oversight ; I think that those who examined the carcases with a view to giving evidence in the case, did not take sufficient care. The two carcases were seized at the same time, one a bullock belonging to Mr. Couper, the other a cow belonging to Mr. Moore ; they were hung in the same room ; the same knife was used by the witnesses for cutting specimens for examination, without being cleaned after each operation. Both carcases were handled by all and sundry without care, notwithstanding that the cow had, undoubtedly, tuberculosis, and that there were grave doubts as to the ailment of the bullock. We hold that if tuberculous bacilli were found on the carcase of the bullock, it was carried from the carcase of the cow.

1810. You know that it is quite possible to convey the *tubercle bacillus* from one animal to another ?—Certainly.

1811. (*Prof. Brown.*) I should like to find out, Mr. Watson, what sort of inspection you, as a practical man, would advise with regard to the carcases of animals killed out of doors ; for example, at what point would you say that you would have the carcase condemned ; if, for instance, you found that the lungs

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and the liver were very much diseased, and the meat was not generally in an emaciated condition, what would you do in regard to that meat?—I might, certainly, be disposed to pass it.

1812. Notwithstanding the fact that the lungs and the liver were filled with tuberculous deposit?—If the flesh showed no appearance of disease, I should feel disposed to pass it.

1813. Would you still be disposed to pass it if, in addition, you found that the pleura and the peritoneum and a large number of the glands were infected, although the meat might, nevertheless, be perfectly healthy to look at?—I do not think that the meat would be healthy in appearance if the animal was infected to the extent you describe.

1814. If I tell you that I am asking the question from the result of my own observation, and that I have constantly seen animals in that condition, what would you say then?—No such instance has ever come under my notice, and I should like to see the animal before I gave an opinion.

1815. Could you bring yourself to eat the flesh of an animal so infected?—I cannot say.

1816. You say you would like to see the animal for yourself?—Yes. If I found that the animal was generally infected to a considerable extent—not only the internal organs, but the pleura and the abdominal lining, and that the disease was spread over the inner lining of the body—I should probably say that the meat ought not to be allowed to go into consumption.

1817. Are you aware that tuberculous meat has been constantly passed by experts?—It has not been passed in Glasgow to any extent since Couper's case.

1818. In the case of a carcase without the internal organs, you do not know, although the meat may appear to be healthy, whether there may not have been tuberculous deposits in other parts?—No, I should not be able to say.

1819. You say that you do not think that what a meat inspector would call excellent meat should be slaughtered and condemned, even if it were proved that it came from a tuberculous animal?—I am not aware that I have said that.

1820. I think I heard you say it in answer to a question from the President. You would not feel inclined to repeat the statement, supposing that you did make it?—Will you kindly repeat the question?

1821. I understood you, in reply to the President, in reference to the inspection of meat in the meat market, to say that if the meat was what the inspector would call excellent meat, even although you knew it had come from a tuberculous animal, you would consider that it ought to be passed?—Well, if I saw it myself, and was of opinion that it was excellent meat, I should consider it fit to be passed; but the inspector's degree of excellence and mine might differ very materially. I am certainly not prepared to say that I would accept every inspector's opinion.

1822. Suppose that you did say it was excellent meat, and that it ought to be passed by the inspector, would you feel inclined to take no notice of the opinion of the inspector if his view was opposed to yours?—I would not accept the opinion of every inspector unless I knew that he was a good judge. Some inspectors know nothing about the quality of meat at all.

1823. What sort of inspectors have you at Glasgow?—Very good. I would take the opinion of the inspectors in the Glasgow market. I believe that two of the inspectors there are about the most excellent judges of meat I know.

1824. You would not extend that statement to the inspectors of other markets, of whom you know nothing?—No, because I have known some persons take part in an inspection who know nothing about meat at all.

1825. Does not that fact, from your point of view, make the whole inspection of meat a very difficult question?—Yes, it does.

1826. Then is it your opinion that the public are not sufficiently protected by the present system of inspection?—So far as that question applies to Glasgow, I think, on the contrary, that the public are very well protected.

1827. But take the whole country?—Some persons are of opinion that only medical officers are fit to be inspectors.

1828. That is not your opinion?—No, my opinion is that the inspectors should be those who know good meat when they see it, and that such knowledge can only be acquired by experience.

1829. You say that you have no evidence to give the Commission to show that meat from a tuberculous animal either is or is not injurious to public health?—I have no idea at all.

1830. Would you, in consequence of that defective knowledge, consider it safe to allow meat to be looked upon by an inspector as good meat, and permit it to go into consumption as human food, until you found out that it was dangerous, if you knew that it came from a tuberculous animal?—Yes, I would if the meat had a healthy, well nourished appearance.

1831. Why?—Because we have no evidence that the community have suffered in the past.

1832. That would be your test?—Yes.

1833. That as long as there is no distinct evidence that any harm is done, you would be prepared to say that the meat inspector, knowing nothing of the condition of the animal at the time it was slaughtered, should declare that the meat was fit for human food, and allow it to go into consumption?—Yes, if the appearance of the meat justified him in doing so.

1834. You said, in answer to the President just now, that the animals which come from Canada and the United States are inspected in Glasgow?—Yes.

1835. What sort of inspection do they undergo?—Animals coming from Canada are allowed to go into the country after a detention of 12 hours. Some are slaughtered, and others are kept for feeding purposes. The system of inspection is similar to that which applies to all other animals sent to the Glasgow market and slaughtered. No animal should be allowed to be slaughtered until it had been inspected, and, if condemned for disease, compensation should be paid.

1836. Are you aware whether the same system of inspection is carried out all over the country?—No, I think not.

1837. Are the animals which are imported from Canada sent generally for slaughter or are they mostly used for store purposes?—Those which are imported from May to August are nearly all for slaughter. After August, probably one-third will be slaughtered and the other two-thirds used for feeding purposes.

1838. After the month of August?—Nearly all those landed prior to August are for slaughter while most of those landed from August to the close of the season are for feeding purposes.

The witness withdrew from the table; but upon an intimation from the President, was allowed to remain in the room while the other witnesses gave their evidence.

Mr. T. Myers and Mr. J. R. Smith.

Mr. THOMAS MYERS, President of the National Confederation of Meat Traders' and Butchers' Associations representing affiliated associations from Birmingham, Bolton, Bradford, Coventry, Doncaster, Dublin, Edinburgh, Glasgow (Wholesale Butchers' Society), Halifax, Hull, Leeds, Liverpool, Manchester, and Paisley; and

Mr. J. R. SMITH, Leeds, Treasurer of the National Confederation of Meat Traders' and Butchers' Associations, and representative of the Leeds Local Association, were called in and examined together.

1839. (*The President.*) We are aware that you are a representative gentleman?—(*Mr. Myers.*) I am.

1840. Representing the important towns of Leeds and Liverpool, as far as the meat trade is concerned?—Yes.

1841. And also representing the general national confederation of the meat traders and butchers which has been brought about by the fact that an extension has been given to the regulations under the Public Health Act as regards meat which is considered to be injurious to health?—Yes.

1842. The proceedings of the public authorities have called your attention to very important matters, as far as your interests are concerned, is that so?—Yes.

1843. You are probably aware that the particular object of the Commission is to inquire what effect the use of milk or meat derived from tuberculous animals has upon the health of those human beings who consume it?—Yes.

1844. Have you any statement or opinion to give which may tend to illustrate that question?—I may say at once that we have come to the conclusion that it would be undesirable on our part to enter into any scientific explanation, because we know there is very much difference of opinion among scientific gentlemen, and that anything we could say upon the subject would not only be unbefitting on our part, but would not be calculated to throw very much light upon it. We can, however, go as far as this: that as long as we have been acquainted with this tuberculosis business, and we have known it from time immemorial, we have never been able to trace any injurious effect from the use of meat. We believe that milk is a much surer way of tracing the effect if there is anything injurious to the health of a human being, and for this reason that milk is taken in the condition in which it is received from the cow, whereas meat, as a rule, is not eaten until after it has been cooked. We believe that in certain stages of this particular disease there is no harm whatever in eating the flesh of an animal which has been suffering from tuberculosis.

1845. You say in certain stages of the disease?—Yes, I mean when an animal is suffering from tuberculosis in the first and second stages of the disease.

1846. Do you think it is difficult to prove when tuberculosis is present? What are the facts you allege in support of your contention that tuberculosis is nothing new, and that it has always prevailed?—It is my belief that it has always prevailed.

1847. Do you believe that there is more of it now than there was when you commenced business?—I should rather say that there is less of it now than formerly, and I can give you my reason for saying so. We are living in more enlightened times now-a-days when there are better sanitary arrangements, improved ventilation, and more cleanliness in the cow-sheds, and so on. The want of these improved sanitary arrangements in former times had an injurious tendency, and was an element of danger. The animals were much too closely confined, instead of being housed in well ventilated buildings with open doors.

1848. Have you observed, in the course of your business, that animals have been brought in for slaughter which were obviously unfit to be slaughtered for human food?—No, I cannot say that I have.

1849. Is it your complaint that the condemnation of meat has taken place, not from the actual condition of the meat when exposed for sale or brought in for human consumption, but from an exaggerated importance which has been given to the symptoms of tubercles in the carcase?—We believe, since the medical officers have had so much power, that this is a thing of which they have taken much more notice than was formerly the case. I believe, in the words of Mr. Chaplin, the right hon. gentleman who presides over the Board of Agriculture, that the disease has been very much exaggerated. I will give you an example: There was a very good bullock killed in Leeds, which had cost something like 33l. It not only looked to be good, but it was an animal that had evidently been well nourished. Certainly, it showed slight signs of this tuberculosis. But the medical officer was sent for, and he condemned it after pieces had been cut out of it here, there, and everywhere. I must say that he was perfectly ignorant as to where the parts were taken from. We did our best to find out everything for him, but he saw that we were inclined to defend the owner of the carcase. It is always the rule in Leeds to get one medical officer to corroborate the statement of another, and in this instance the decision upon the case had to be postponed until further evidence could be called in. It was called in, however, and in the end the carcase was destroyed. But I wish to show you that the condemnation of the animal was a mere fad of the inspecting officers. One half of the animal was perfectly fit for food, and the medical officer could never have told that it came from an animal which had been suffering from tuberculosis. He admitted that what was shown to him gave no signs of disease; but, nevertheless, he said that the whole carcase was infected, and must be destroyed. He even went so far as to destroy the hide. I think you will agree with me that, as the hide has to go through the tanning process, it might have been left for the owner of the animal. I have mentioned this case to show that the medical officers show by their action that they allow themselves to be biased in their judgment.

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1850. Can you tell me of any place, Liverpool, Leeds, or anywhere else, where the greater activity, and, as you think, the unnecessary activity, of the inspecting officer has produced such a result as that the supply of home-bred animals for slaughter has been diminished?—I would mention Leeds as one place.

1851. In Leeds that has been the case?—Yes.

1852. Can you mention any place which has been affected by the decrease in the number of home-bred animals sent into the market in which the deficiency has been filled up by animals imported from abroad?—I know that that is so.

1853. Has it been the case in regard to sheep also?—It has been chiefly so in regard to beasts.

1854. Is it part of your contention that, so far as the animals which come from abroad are concerned, it is impossible, even for the most experienced judge, to say that the carcases imported may not have come from live animals which, at the time they were slaughtered, were infected with tuberculosis?—No, I do not mean that at all.

1855. I understood you to say that the supply of live animals brought into Glasgow to be slaughtered has diminished?—The supply in Glasgow?

1856. That the supply of live animals has diminished in consequence of a more close inspection?—I was speaking of Leeds, not of Glasgow.

1857. Then tell me as to Leeds?—I quite understand the question, and applying it to Leeds, I should say that there is now more foreign meat brought into Leeds than was the case formerly.

1858. What I want to know is whether, since the home supply has diminished, the foreign supply has increased?—Yes.

1859. Is it possible, in the case of animals imported from abroad in the carcase, to say whether or not they were the produce of animals infected with tuberculosis?—All I can say is that we have seen many animals brought in which we should be prepared to say had had the disease.

1860. Have they been condemned by the inspector?—No, they have not been condemned. Very probably the inspector did not see them.

1861. How was that?—The attention of the inspector was chiefly drawn to the animals which we are killing. I think I may fairly and truthfully say that I have hardly ever seen any inspection of the carcases of meat which have been brought into the town of Leeds.

1862. Whether from abroad or elsewhere?—Exactly so; it is only the live animals, and not the carcases, that are inspected.

1863. Is it not the case, or, rather, is it your own view, that if the carcase which is intended for consumption appears to be wholesome and healthy you need not inquire too closely what the condition was of

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the lungs and offal which have been thrown away?—Unfortunately, they are never sent.

1864. But is it not part of your contention that if the carcase, after it has been cut up into joints, appears to be healthy and good, it is not necessary to inquire into the condition of the animal when alive?—I should say so.

1865. In the case of advanced tuberculosis, is the condition of the animal itself in its lifetime sufficient evidence that it ought not to be sold for human food?—Yes.

1866. But what would you say if the animal appeared to be healthy and well nourished, and fit for food; would you say that it was sufficiently wholesome to go into consumption?—Certainly.

1867. And you do not think that the public health would suffer to any extent in consequence?—No.

1868. I presume you are aware that modern science has made it pretty clear that tuberculosis in animals is very much the same disease as consumption in mankind?—Yes.

1869. But you are not prepared to admit, in fact, you do not believe, that consumption in mankind has been provoked or greatly increased by eating meat and drinking milk from tuberculous animals?—Only in regard to milk. I do not think it has come from the eating of meat at all. I think that, personally, I represent a fair specimen of a person who has not sustained much harm from eating meat.

1870. Nevertheless you think there ought to be a rigorous inspection of animals intended for human food in the slaughter-house in which they are slaughtered, and of the dairies where the milk is collected and distributed?—We have always advocated that such inspection should take place; we have always moved in that direction. As a matter of fact, in Leeds, where I come from, the corporation, after many struggles on our part, have appointed several of us as jurymen.

1871. Would you, as a practical man, go as far as to say that the appearance of an animal when sent up for slaughter, if you cannot find indications clearly pointing to whether it is fit for consumption or not, should be sufficient to justify its sale as food?—In the case of an animal infected with tuberculosis, if it was in what we call the third stage, it would so show itself that we should be able to tell at once that it was suffering from disease.

1872. Is it within your experience that animals suffering from the third stage of the disease are frequently brought into the market and purchased for consumption?—I never knew that to be the case in Leeds.

1873. Such animals would be rejected?—Yes, most certainly.

1874. Even by poor people who cannot afford to give the best prices?—They would, and we should uphold them in doing so. There would be no attempt, however, to expose such meat for sale.

1875. (*Professor Brown.*) May I ask you if you are thoroughly acquainted with the system of meat inspection?—Yes.

1876. Are you aware of the existence of any test that would enable you to say by looking at the meat of an animal exposed in the meat market, and knowing nothing of the history of the animal when alive, have you any test that would enable you to say that the meat obviously came from a tuberculous animal, and not from one which had been suffering from pleuro-pneumonia?—Notwithstanding our lengthened experience we have no scientific test that would enable us to say whether the meat was good or bad.

1877. That I am aware of, but would you be able to say at once if it was bad meat; that it was bad in consequence of having come from a tuberculous animal?—We could not, apart from certain things attached to it; we could not tell by the flesh alone.

1878. I am speaking of a case where there was no trace of actual tuberculous deposits. Could you say that it was bad and had come from an animal suffering from tuberculosis, looking merely at the meat? Would there be anything in the meat itself to show that it was undoubtedly meat from a diseased animal, and would you be able to say from what disease the animal had suffered?—There might be one thing that would be a guide, but I think it would be very slight and very unreliable.

1879. What is it?—It is my belief that if an animal in apparently a good condition has been suffering from a severe infection of tuberculosis, the flesh would be a little more glossy than usual, or something of that sort. But I should not like to express any decided opinion in the matter.

1880. If you were examined on oath you would not like to say positively that the meat was taken from a tuberculous animal?—Certainly not.

1881. (*Chairman.*) May I ask you, Mr. Smith, whether you concur in the evidence which has been given by Mr. Myers?—(*Mr. Smith.*) Quite so.

1882. Is there anything he has omitted that you would like to supplement?—There is only one thing. I have been a purveyor of meat in the course of my time for Jews. The Jews are a people who are very particular as to the character of the meat they eat; but I can testify that, notwithstanding the care they exercise, they have had an equal share of consumption with other people. I have long been perfectly convinced that the interior organs of an animal may have tubercle in them without the disease reaching the meat intended for consumption as food.

1883. As far as you are aware, have your customers who were Jews been more particularly free from consumption than other people, or do they take their chance along with other people?—They have had to take their chance along with other people.

1884. You have not observed that they have been especially healthy in this respect?—I do not think that the Jews are more particularly healthy than Christians.

1885. Is that your opinion also, Mr. Myers?—(*Mr. Myers.*) It has been said that Jews are practically free from this complaint. I have had some experience in the matter and I know that it is not the fact.

The witnesses withdrew from the table, but remained in the room during the rest of the evidence.

Mr. E. Lister, Mr. W. H. Hill, and Mr. T. Myers.

Mr. Edward Lister, Mr. Wm. Henry Hill, representing the Sheffield Butchers' Association, called in and examined, and Mr. Thomas Myers.

1886. (*Chairman.*) You are both gentlemen from Sheffield, I think?—(*Mr. Lister.*) Yes.

1887. Have you had practical experience in the butchers' or fleshers' trade?—Yes.

1888. Both of you?—Yes.

1889. But you represent, I suppose, besides yourselves and your own opinions some association or trade interests in Sheffield?—Yes, the Sheffield Association of Butchers, who are more than 200 strong.

1890. Your association does not go beyond the town of Sheffield?—No.

1891. Has anything occurred in Sheffield or in the carrying out of the Public Health Act which has caused your trade to associate themselves together with a view to the representation of any interests?—Yes, the taking away of 11 carcases of beasts which have been touched with tuberculosis.

1892. Do you contend that that has been improperly done?—What we contend is that when, as butchers, we go to market and buy a beast, it is impossible to detect tuberculosis in any beast in the early stages.

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1893. In its early stages?—Yes, when the animal is alive.

1894. You do not say in any stage, only in the earlier stages?—Yes, in its earlier stages we say that it is impossible to detect the disease in a living animal, and our complaint is that when we have bought a beast which is afterwards condemned, because it has been suffering from tuberculosis, we have no remedy if it is taken away and destroyed. We are unable to recover payment and are consequently out of pocket. (*Mr. Hill.*) Allow me to put in a return from our medical officer, which shows the number of beasts which have been condemned during the last 12 months. (*Return handed in.*)

"Sheffield Sanitary Authority,
"Health Office, North Church Street,
"Sheffield, June 3, 1890.

"Dear Sir,

"In the year from 1st June, 1889, to May 31st, 1890, inclusive, 56 carcases have been condemned by the Health Department and destroyed as unfit for food, by reason of their being affected with tuberculosis. Of these 56, one was a pig, and the rest of the bovine species.

"Yours faithfully,
Theodore Thomson.

"Mr. Geo. A. Woodcock,
"276, Pitsmoor Road."

1895. When you say that in the earlier stages it is impossible to detect tuberculosis in a living animal, do you say that the meat of an animal in that condition has been condemned by the inspector?—(*Mr. Lister.*) Yes, we do.

1896. And you say that it ought not to have been condemned?—Yes, we think that in its earlier stages it is not condemnable.

1897. That although there may be some trace of tubercle in the animal, if it were well inside and were fit for slaughter, *primâ facie* it ought to be fit for human food?—Yes.

1898. You do not say that all meat with tuberculosis in it ought to be consumed by mankind?—No.

1899. But you say that a tuberculous animal may produce meat which is not to be distinguished from wholesome meat?—Yes, you cannot distinguish between the two. If you take the internal organs affected away, you cannot distinguish it from the meat of any other beast.

1900. A butcher, of course, must take his chance like any other trader. He purchases that which he thinks is sufficient for his purpose?—Yes.

1901. If he purchased what was obviously diseased you would not contend that he should not suffer for it?—(*Mr. Hill.*) Allow me to explain. In most markets there are veterinary inspectors who inspect the live cattle shown for sale, and whose duty it is to condemn it when they find it infected; but so far as the disease in its earlier stages is concerned, it is impossible for the veterinary inspector or the butcher who has purchased the animal to detect the existence of tuberculosis. He does not know that it is diseased until after it is slaughtered.

1902. Is it not possible for certain butchers to be found who would buy diseased animals and sell the meat from them at less than the value of good meat?—Well, there are always dishonest men in every trade; but speaking as far as tuberculosis is concerned in its earlier stages, our contention is that it is impossible to detect it in the earlier stages when the animal was alive and the butcher was induced to purchase it.

1903. That is not always the case, I presume?—Yes, it is so in every case.

1904. Only in the early stages?—(*Mr. Lister.*) Yes, in the early stages.

1905. The disease, then, passes into a stage when it is obviously easy to detect disease?—Yes.

1906. You would not suggest that animals of that sort should either be purchased or consumed, or that the purchasers should be compensated if the animals are condemned?—Oh, no.

1907. You say, then, that if a butcher buys a healthy well-nourished animal in the market, such as appears to be fit for human food, he ought not to be the loser if tubercle be found to exist in the animal subsequently?—Yes, that is so.

1908. But if it is badly diseased it should be condemned?—(*Mr. Hill.*) Yes, and be destroyed for the benefit of the community.

1909. What is the condition of the lungs and other organs in an advanced stage of tuberculosis?—They are in a shocking condition.

1910. That is not the kind of meat you would complain of as having been improperly condemned?—No.

1911. You do not object to such meat being condemned?—No; but at the same time, an animal may have tuberculosis badly in the lungs and other internal organs without the flesh being at all affected.

1912. Are you prepared to say that the condemnation of meat has been a condemnation of meat which no butcher would say was otherwise than wholesome?—What I am prepared to say is, that I have seen a number of carcases condemned which I considered to be wholesome.

1913. Yet they were condemned by the inspector?—Yes, they were condemned by the inspector.

1914. Not from the condition of the pieces of meat themselves, which obviously showed that they were unfit for human food?—No.

1915. But from the condition of the lungs or pleura, which had been already cut away?—I may say that the medical officer and inspectors in Sheffield go to a far greater length than those in any other town.

1916. What is the reason?—Because, after the trial in Glasgow, which first directed attention to the subject, our medical officer laid down the dictum that if you found a single tubercle in a carcase or in any portion of a carcase, the whole should be condemned as unfit for human food.

1917. What have you to say on the subject of your contention that in the case of healthy meat, even if tubercles are found in the lungs, such meat may be eaten without danger?—I have this to say, my lord, speaking for myself, that I have seen a number of carcases which have been infected in the internal organs, and yet there have been no signs of tuberculosis in the flesh. For instance, you may find tubercles in the wind-pipe, in the lungs, on the pleura, and on the diaphragm, but you will not find them in the kidneys or the kernels, as the lymphatic glands are called, in the neck or in the hind quarter.

1918. And you say that the meat in such a case may be eaten with impunity, without any necessity for impounding it?—I think so.

1919. Have you any argument in support of that view?—Simply this, that I never heard of a case in which it was shown that it could not be eaten with impunity.

1920. You are aware that scientific investigators have recently proved that tuberculosis in animals is identical with consumption in mankind?—I am aware that it is said so, but, on the other hand, I am also aware that experiments have been made which have demonstrated that it can be conveyed by inoculation from animal to animal, and that the results are not altogether the same in the case of animals as in mankind.

1921. Let me take your own town for example—Sheffield; is there a great deal of consumption in Sheffield?—Not as much, I believe, generally, as in some other towns; it is a healthy place.

1922. As far as you know, Sheffield is a healthy place?—Yes.

1923. Has there been no increase of consumption of late years there?—Speaking generally, I should say there has not.

1924. On the other hand, can you say whether there has been an increased number of tuberculous animals taken to the market in Sheffield, compared with what was the case in former times?—I should

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say that, speaking of recent years, the number has been less.

1925. Has the greater rigour now exercised in the inspection of the markets precluded an increase?—(*Mr. Lister.*) The fact is that, although they do not find their way into Sheffield, they are sent to other towns where the inspection is not as severe.

1926. Is that a matter of complaint in the interests of Sheffield?—No, I do not think it is a matter of complaint. (*Mr. Hill.*) There is one thing I desire to point out. Both my colleague and myself have noticed that the bulk of cases of tuberculosis has been in cows, and not in bullocks. Many of them have been milking cows or dairy cows which have been fattened for sale, but, in consequence of the rigid manner in which the inspection now takes place in Sheffield, no butcher has offered to buy these cows. That may be one reason why the number of tuberculous animals sent to the market has decreased; but since this Commission has been sitting, our medical officers and inspector have relaxed their rigour, and I have only heard of a very few cases in which animals have been condemned, except cases in which they have been very justly condemned. The inspection is nothing near as rigorous as it was 12 months ago.

1927. Is it not the object and intention of the Public Health Act to remove from the public the risk of consuming unwholesome meat?—Yes.

1928. Is it your view that that provision, which is a very reasonable one in itself, has been carried too far, and has, in reality, injured the trade by condemning meat apparently healthy, but which is now considered by a scientific inspector to be injurious to health?—(*Mr. Lister.*) That is the complaint which we make, because, undoubtedly, the butchers have been made to suffer personally. We think that if the Government requires a beast to be condemned which is apparently healthy, and which it was impossible for the butcher, at the time he purchased it, to know was suffering from tuberculosis, it ought, at the same time, to provide compensation.

1929. I am quite aware of that, and might be prepared to agree with you, to a reasonable extent, but the question of compensation is not the question with which we have to deal. Is there anything you can adduce, in support of your contention, that a great deal of meat that has tuberculosis in the lungs may, nevertheless, be fit for consumption?—(*Mr. Hill.*) I have a report here from Dr. G. Newton Pitt, one of the physicians in Guy's Hospital. We sent up to Dr. Pitt a piece of meat which was taken, by the permission of the inspector, from a beast which was badly diseased, as far as the internal organs were concerned. It was a piece of the mid rib, with tubercles attached, and we asked him to examine them microscopically and otherwise. He sent us his report, with a full description of his experiments; and it appeared that he could find no trace of any bacilli in the flesh. There were no tubercles whatever to be found in the flesh, and Dr. Pitt stated it as his opinion that the meat was perfectly fit for food.

1930. Do you know whether the gentlemen who compose your association reject cows that are offered for slaughter if they are animals that are evidently wasting away from the effects of tuberculosis?—Certainly.

1931. If they do purchase them, would they not do their best to remove from the public eye any trace that would show a risk of the danger that would be incurred in making use of the animal as food? Do you think they do that?—Probably they might; but I think that, as a rule, they would not dress such an animal for food. They would know that it was unfit for food.

1932. Would not any experienced butcher, in a good way of business, select animals that, in his judgment, were altogether free from disease?—Yes, certainly.

1933. And in which the flesh was apparently fit for human food?—Yes.

1934. Do you think that if the meat of an animal infected with tuberculosis, but which was apparently healthy, has been used for human food in Sheffield of late years, such meat may have been productive of the disease of consumption?—I think not.

1935. You think that if it had been the case some proof of the fact would have been ascertained by this time?—Yes.

1936. Is it your opinion that the case against this meat is a case of suspicion only?—Yes.

1937. Are you aware whether there has been any attempt to prove that the meat has been improperly condemned?—Yes; and I am aware that much surprise has been expressed, and that there has been some controversy.

1938. Do you not think that if it could have been proved that the consumption of meat of this kind was injurious to health, the fact would have been clearly proved by this time?—One would think so.

1939. Is that your opinion also, Mr. Lister?—(*Mr. Lister.*) I may say that I have been a butcher for 40 years, and I have killed a good many animals myself, in addition to those which have been killed by my men. I am both a wholesale and a retail butcher. I have had, during that lengthened period, many of these beasts which have had a touch of tuberculosis, but I never heard of anyone having suffered from eating the meat which came from them. If we have a bad liver, we throw it away. If the lungs are infected, we take them out and throw them away. I have never sold anything that was in the least degree infected with disease, whether tuberculosis or anything else. I take it that animals with good points are as liable to be attacked with this disease as animals with poor points. What we say is, that when the disease is merely local, and the infected parts are taken away, there is nothing injurious in the good meat which remains.

1940. I quite understand that that is your contention as regards tuberculosis in its earlier stages?—Yes, it is so.

1941. If the tuberculous disease proceeds further, and comes to its final stages, the meat is obviously infected, and is unfit for human food?—Yes, in that case it is unfit for food.

1942. That can be clearly ascertained and seen by any skilled butcher?—Yes, he would see what was the matter, if the disease had reached an aggravated form, and he would send at once for the inspectors.

1943. In that case the meat would be bad from its general appearance or from the presence of tubercle in the flesh?—I never saw tubercle in the flesh.

1944. Then what would the appearance of an animal, such as you have described, present?—It would be shrunk down, and badly diseased in the internal organs. It would only do for what we call a "screw."

1945. What do you mean by that?—There are butchers who sell bad inferior meat, after the same has passed the inspector, which goes by that name.

1946. What would be the condition of the flesh?—(*Mr. Hill.*) The tissues would be flabby and watery.

1947. No butcher in his senses would purchase and slaughter an animal in that state?—No man of experience would; he would certainly not do so of his own choice.

1948. If he found that he had slaughtered such an animal, would he not at once withdraw it from consumption?—Yes, he would do so in his own interest.

1949–50. And he ought not to complain if the inspector stepped in and condemned it?—Certainly not. (*Mr. Lister.*) Perhaps I may be allowed to explain what I have found to be the case in regard to a milking beast, when a dairy cow has this disease the tubercle invariably attaches itself to the udder through which the milk passes. I think that a very great deal of disease springs from our dairies, which are distributed up and down our towns, and which contain cows suffering from tuberculosis which the inspector cannot get at. The milk from these cows is sold for consumption all through the town. The cow-sheds are ill-arranged and badly ventilated places. The animals inhale each others' breath over and over again in the most unhealthy buildings, and disease is conveyed from one to another. To a very great extent, in my opinion, it is in these dairies, among the milch cows, that tuberculosis has its seat.

1951. Is there no inspection of the dairies?—Not in our town.

1952. Is there not such a thing as the Dairies Act?—We have it in Sheffield, but I believe it is not in the power of the authorities to inspect the dairies and impose regulations.

1953. If the powers under the Act are imperfect, you would not object to hear that they were made more stringent?—I think they ought to be made more stringent.

1954. (*Dr. Payne.*) I think I understood you to say that tubercular disease is more common in cows than it is in bullocks?—Yes, and it is more common in aged cows than it is in young ones.

1955. Do you kill much cow beef in your town?—A good deal, but I cannot say what proportion.

1956. At any rate there is not so much cow beef as ox beef?—No, but the number of cattle killed in Sheffield during the last year or two has considerably decreased.

1957. Owing to the more rigorous inspection?—(*Mr. Hill.*) Partly on account of the more rigorous inspection, and partly on account of the American cattle, which are imported in large quantities.

1958. The proportion of cows killed is a good deal less than that of oxen?—Yes, a good deal less.

1959. What kind of cows are fattened for slaughter? Are they cows which have ceased giving milk or cows that do not give enough milk?—Generally cows that have ceased to give milk, cows that have ceased bearing calves.

1960. Are the cows killed a good deal older than the oxen on the average?—Yes, on the average.

1961. What is the limit of age at which you kill oxen?—There is no limit as to oxen, but the bulk of them will probably run from 18 months to two years of age.

1962. They are not often killed over two years of age?—No; perhaps from two to three years. The bulk of them, however, are killed when from 18 months to two years old.

1963. An ox is seldom killed over three years old?—No.

1964. What is the age at which cows are killed?—I cannot say; it is an indefinite period.

1965. How old may they be allowed to run to?—They are killed of every age, up to 8 or 10 years old.

1966. But the cattle killed generally are not more than from two to three years old?—The age will vary. For instance, if a person has a heifer which bears calves when very young he will fatten it up for the market when it gets to be three or four years old.

1967. But I presume it is only very seldom that a heifer would be killed at the age of three years?—Yes, plenty of them.

1968. There are a good many killed at that age?—Yes.

1969. When cows are slaughtered for beef do you examine the udder?—Before slaughter or after?

1970. After slaughter?—Not specially. For what purpose?

1971. We have been told by a gentleman on your right that the tubercle generally affects the udder of cows?—Yes, and for this reason, in all cases or nearly in all cases, of cows suffering from disease I have carefully examined every portion of the udder to ascertain, if possible, where the tuberculosis existed, and in every case I have found it in the udder and in the teat. I may say that in the case of the report which I put in from Dr. Pitt, the case of a cow which had been milked in the town for more than two years, the udder was in a very bad state of tubercle.

1972. Have you often seen tuberculosis in calves?—No, not in calves.

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1973. Not at all or very rarely?—Only very rarely.

1974. Do you think that tuberculosis is more common in the older cows than in the young ones?—Yes, undoubtedly.

1975. (*Prof. Brown.*) One of your complaints in Sheffield is, and it is a tolerably general complaint, that you buy animals which are apparently healthy, and that after slaughtering them they are inspected, found diseased, and condemned. You complain of that proceeding on the part of the local authorities?—(*Mr. Lister.*) Yes.

1976. Is there no system of warranty known in the trade?—None.

1977. It is not at all like dealing in horses?—Not at all.

1978. I should like to know if there is any special reason for that?—We could not get the parties who sell the beasts to give us a warranty.

1979. Supposing that the practice became universal and it was determined that it should be so, and that all buyers should insist on having a warranty, do you see any objection to such a system?—No, I do not.

1980. I merely want to know how it is as a matter of practice?—Nothing of the kind is done at present.

1981. It seems to me that it would be one way of getting rid of a good deal of difficulty. Do you happen to know whether the trade has ever thought of the subject?—Yes. We have asked for a warranty, but the sellers have always refused to give one since this question of tuberculosis came up.

1982. You have no means of putting pressure upon the sellers?—No.

1983. Could not you do so if you chose, through your association?—I think not.

1984. Could you not say that you would not buy without a warranty?—It is a free market and if we do not buy the animals sent there, other persons will step in and do so.

1985. You see a difficulty in the matter?—I feel persuaded that we could not enforce such a system.

1986. Not as an association?—No.

1987. Have you seen many tuberculous animals?—Yes. I have had many in my hands during my experience, but I have paid more especial attention to them since the time the provisions of the Public Health Act began to be put in force.

1988. Is there anything that would enable you to say that the disease when you see it is tuberculosis or not the effects of some other disease?—If it is tuberculosis then there is what we call the grapes in the parts infected.

1989. But taking it for granted, and only looking for it in the flesh, have you easily detected it?—No, I never found tubercle in the flesh.

1990. In examining the flesh of an animal which had the disease in a bad degree, and the meat was obviously bad, you would condemn it?—Yes.

1991. Would you know that the flesh was taken from an animal suffering from tuberculosis or from some other disease?—No.

1992. Would you, Mr. Hill?—(*Mr. Hill.*) No, I think not. You spoke just now of a warranty. I should like to explain that we have tried the case of a warranty by taking a test case before the judge of the Wakefield County Court. The beast which turned out to be diseased was bought at Wakefield, and an action was brought against the seller to try the question whether there was an implied warranty. The judge decided to the contrary. We have since raised the question of an open warranty, but we found a difficulty owing to there being no uniform system of inspection.

1993. I think you stated that you have not found tubercle in the kernels or glands?—I said that you may find bad cases of tuberculosis in the lungs and other internal organs without finding any tubercle in the kidneys, and kernels or glands.

1994. You have no scientific knowledge of that fact?—No, but I have gone over a number of beasts in the presence of veterinary surgeons and have found it to be so. I may say that one of the worst cases of

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tuberculosis I ever saw was that of a young Irish heifer, and I did find the tubercle both in the kernels and in the kidneys. But in a majority of cases the tuberculosis has been local, and I have not found it in the kidneys or in the kernels.

1995. You are not aware probably that we have found bacilli in the glands at a very early stage of the disease, when there was no tuberculosis perceptible to the naked eye?—That is a scientific point which I am not prepared to go into.

1996. Then as to the tuberculous state of the udder, you say that generally in the case of tuberculous cows they have the tubercle in the udder?—Yes.

1997. Do you mean that the tubercle has been evident to the naked eye?—(*Mr. Lister.*) Yes.

1998. You considered it to be tubercle?—(*Mr. Hill.*) Yes. It was the same in the lungs which were condemned.

1999. I have asked the question because I know that in a large number of cases of tuberculosis the udder has not shown the slightest evidence of disease. That has been determined by scientific examination. I gather that you do not consider it satisfactory to draw conclusions as to the effect upon a human being of eating meat from a tuberculous animal from the conclusions which have been drawn from experiments upon the lower animals?—Yes, I said so.

2000. Does that express your view?—It does.

2001. And you would not be satisfied if it were proved to demonstration that the eating of tuberculous meat from an animal that appeared perfectly healthy, and had no bacilli after examination by an expert who reported that they were not to be found, you would not be satisfied if part of that flesh were given to rabbits and guinea pigs, and they became tuberculous, you do not think it would be fair, under such circumstances, to draw the conclusion that there was tuberculosis in the animal from which the meat was taken, and that by eating it the disease might have been conveyed to a human being?—No, I should not.

2002. According to your view, in order to determine the point now before the Commission, it would be necessary to try experiments on the human subject?—No, I do not say that. What I do say is that I do not believe that meat from a tuberculous animal in the earlier stages of tuberculosis has ever been proved to infect a human being in the way that some scientists say that it has done.

2003. That is not my question. The point I want to ascertain from you is this; whether or not you will agree that experiments producing certain results in the lower animals, would justify us in drawing the conclusion that the same results would follow upon the same experiments in connexion with a human subject?—I should not be prepared to say so myself. I have no evidence.

2004. You say you have no evidence?—Yes.

2005. You are aware of no case of tuberculosis in the human subject in which consumption has arisen from the use of meat taken from a tuberculous animal?—(*Mr. Lister.*) I never heard of such a case, and I have never seen one.

2006. And is it on that account you say that you consider there is no objection to the use of meat from a tuberculous animal, provided the meat is what a butcher would decide to be good meat?—I should have no fear in eating it myself. That is all I can say.

2007. Then if you would not fear to eat it yourself, you would not fear to offer it to anybody else?—No, I would not be afraid to offer it to anybody else, if the tuberculous matter was local and had all been stripped cleanly away.

2008. Have you ever heard of any case in which a human being has been infected by eating the meat of what you call "wasters." They are among the worst cases of tuberculosis, I believe?—Yes.

2009. Have you heard of people becoming infected through eating the meat of such an animal?—I can only say that the animals you refer to are very bad cases, in which the animals ought to have been condemned.

2010. Have you any evidence that the consumption of the flesh in extreme cases of tuberculosis of this nature in a variety of ways has ever produced harm to a human being?—Not to my knowledge.

2011. Then you are equally without evidence as to the harmlessness of meat in the most trifling cases and in the very worst cases?—Yes, I am equally without evidence. I may say, in regard to the effect of condemning meat, as it is condemned in Sheffield, that the butchers themselves have been induced not to buy cows. They refuse to buy them on account of the risk they run of having them condemned, and for fear they should find them infected with tuberculosis. The result is that the dairy-keepers now keep them as long as they can stand upon their legs, and continue to draw and dispose of milk from them for consumption as long as they continue to give any. This milk is given to the younger portion of the community, who drink it as food; to my mind that constitutes the greatest danger.

2012. The drinking of tuberculous milk?—Yes; it is a far greater danger than eating meat from an animal that may have had tuberculosis.

2013. Do you not think that all danger would be avoided if every diseased animal were killed, and the risk of allowing tuberculous animals to go into consumption as meat were avoided?—Yes, I do; and if compensation were allowed the butcher would not hesitate to kill all such animals. But what I say is that there is far greater danger from the dairies where the cowkeepers keep cows confined in a vitiated atmosphere, and where, as a consequence, in a large town like Sheffield the bacilli are scattered about broadcast.

2014. Do you consider that the Agricultural Department should pass an order to compel the slaughter of all obviously diseased animals, in order to prevent their use as food?—Yes, I do.

2015. And you think that the Government should give compensation?—Yes, where the owner is not to blame.

2016. How would you discriminate?—Suppose I go into the market or into a cow-house and buy what I consider to be a healthy beast, and give a good price for it, and then find that it is suffering from tuberculosis. Possibly I may have given 20*l.* for it, but I am bound to kill it, because it is discovered to be infected with the tubercle. My complaint is that in such circumstances I should be condemned to stand the entire loss of the 20*l.* I have paid in perfect good faith. It would make me hesitate before I purchased another animal.

2017. Do I understand you to say that you would not hesitate to pass an order to prevent dairy cows that are diseased from being used?—Yes.

2018. Do you consider that the order should include compensation to the owner of an obviously diseased animal?—No.

2019. You would seize the animal because it was diseased, and slaughter it?—Yes.

2020. Would you compensate the owner after you had killed the beast?—(*Mr. Hill*). I would not myself, because being *obviously* diseased, it would be in an advanced stage, and consequently unfit for food, a "waster" in fact.

2021. Would it be a proper course of procedure on the part of a Government department to seize a man's cow and kill it, and not pay him for it?—(*Mr. Lister.*) If it were found to be diseased it ought to be killed.

2022. But it would not be discovered to be diseased until it had been seized and examined. In that case would you compensate the owner of the animal, after you had killed the diseased cow?—No, I would not.

2023. You think it would be reasonable on the part of a Government department to order the slaughter of an animal without paying compensation?—Yes, under the circumstances you have mentioned; but if it were not found to be diseased then the Government should pay compensation.

2024. They would be liable in that case to pay the full value of the animal?—They ought to do so.

2025. That is not a case in point. You say that where the animal is obviously diseased, compensation should not be paid?—That is my idea, as a practical man.

2026. (*Chairman*). I believe, Mr. Myers, that you wish to add something to your evidence?—(*Mr. Myers.*) I should like to make a few remarks upon what has been said since I was examined.

2027. You cannot say anything in the way of a commentary upon the evidence, but we will hear anything further you may have to say by way of evidence upon your own account derived from your own experience?—Mention was made of the propriety of getting a warranty. One of the Commissioners asked if there could not be a warranty.

2028. That is not a proper subject to be debated here, although it may be of importance to consider the matter?—I only want to mention that in the shorthorn class great importance is attached to the blood and pedigree, and it is the object of the breeder to keep it continuously the same. But now that the cowkeeper finds that he has a difficulty in selling his cows, owing to the prejudice which exists in the trade, who are afraid to buy them, he allows them to run dry, and puts them to the bull again. He then sends them for sale by auction; nobody knows anything about them, and the result is that they may inflict great injury upon a large stock of other goods. I would certainly, in order to remove this complaint, give the dairy keeper every facility for getting rid of his stock, and if he was found in possession of animals that were suffering from tuberculosis, and were unfit for human food, I think it would be far better to destroy them, and to compensate him, rather than to allow him to breed other diseased stock, and contaminate other people's animals by sending his own round the country.

The witnesses withdrew.

Inquiry adjourned until the 7th of January, 1891.

ROYAL COMMISSION ON TUBERCULOSIS.

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Human and bovine tuberculosis are identical, but the latter is the more virulent, *Dreschfeld*, 165; *Woodhead*, 219–30; *Squire*, 926–34; *Powell*, 1125–30; *Goodhart*, 1362, 1363; *Horsley*, 1630; *Klein*, 543–49, 574.

A clearance of diseased animals in Edinburgh, under the clause of the Act relating to pleuro-pneumonia, showed that 120 of 300 cows supplying milk were tuberculous, *Littlejohn*, 1463–7.

Cattle and their sheds must be regularly inspected, and persons suffering from tuberculosis should not be permitted to serve in the sheds, *Dreschfeld*, 167, *Littlejohn*, 1581, 1582.

Experiments upon Animals.

Experiments on rabbits with meat from tuberculous cows, *Dreschfeld*, 1–187.

Feeding experiments on calves, *Woodhead*, 457–64. Tuberculosis produced by inoculating animals with the apparently healthy organs of an animal dying from tuberculosis, *Woodhead*, 399–404.

Susceptibility of Animals to Tuberculosis.

Animals in the open air are less liable to the disease than those herded together; pigs are rendered liable by their habits, *Dreschfeld*, 119; *Squire*, 975–82.

The disease has not been found in wild animals, *Squire*, 974.

Herbivora suffer more than carnivora, this suggests that inhalation is more liable to infect animals than ingestion, *Squire*, 983, 984.

Poultry are very prone to the disease, *Dreschfeld*, 147–50.

There is as much—*Watson* 1779–82—and even greater danger from poultry and rabbits than from meat, *Horsley*, 1687.

Dogs and cats are not susceptible to the disease, *Dreschfeld*, 131, 132, but tuberculosis in the former has been met with, *Dreschfeld*, 174–6. Comparative liability of different species of animals, *Klein*, 753–89.

The rapidity of the spread of disease in animals depends on their constitution and age, the older and weaker the more susceptible they are, *Woodhead*, 372–5. This especially applies to cattle, *Lister*, 1972–5.

The percentage of calves condemned in Copenhagen is small, as is that of sheep; about 17 per cent. of all the meat is found to be infected. *Woodhead*, 324–8, 346–50.

Hereditary disease or predisposition to disease in animals. *See* Hereditary Tuberculosis.

Disease in Animals generally.

The appearance of animals suffering from various diseases, *Watson*, 1794–1801. Danger to human beings from the consumption of food from tuberculous animals. *See* Food, Tuberculous Meat, and Milk; and Inspection.

ATMOSPHERE, THE:

The existence of tubercle bacilli in, *Klein*, 791–815, especially in streets of large towns and in workshops, *Klein*, 793–7. They have been found in the dust of Brompton Hospital, *Klein*, 898–904.

It seems that tubercle bacilli are very widely spread, and dependent upon individual susceptibility to take root, *Goodhart*, 1380, 1381. So widely spread that, were it not for the resisting power of human beings, they would clear off the human race, *Littlejohn*, 1486–9.

BACILLI, TUBERCLE:

The experimental methods of introducing the bacilli into the subject, the results of these methods, the difference in potency of the bacilli from different sources and upon different subjects, *Klein*, 816–24, 830.

Tubercle bacilli in milk and dairy products, *Woodhead*, 235–7, 379, 380.

Bacilli in the dust might infect milk, *Ransome*, 1341, 1342.

Possibility of the existence of the bacilli in the atmosphere, *Klein*, 791–2. In the streets and workshops, *Klein*, 793–7. They have been found in the dust in Brompton Hospital, *Klein*, 898–904.

Their presence in the air is not alone sufficient to cause infection, a predisponent condition is an important factor, *Klein*, 811–5; *Goodhart*, 1380–1.

The presence of the bacilli is a necessary factor of the disease, *Klein*, 591–4; *Squire*, 926–55.

Bacilli in patients' breath, *Ransome*, 1327–33.

The bacillus in caseous glands, *Goodhart*, 1378, 1379, 1395–9.

The bacillus is in everyone, and only a susceptible condition is wanted to cause it to take root, *Goodhart*, 1393–4, and it becomes more virulent under insanitary conditions, *Ransome*, 1272–9.

BACILLI IN THE AIR. *See* ATMOSPHERE.

BANG, PROFESSOR:

Experiments by, demonstrating tubercle bacilli in milk, *Woodhead*, 235–7.

BARLOW, Dr. THOMAS, M.D., F.R.C.P., Physician to University College Hospital, London, and to the Hospital for Sick Children, Great Ormond Street, London. Analysis of Evidence of.

Past experience and appointments, 1002–10.

Witness's observations tend to the direction that the disease must be produced by an infection *ab extra*, 1011–20.

Hereditary Tuberculosis.

The inheritance is not of disease, but of a predisposition to it, or weakness, rendering the body less able to resist the attack of the invading tubercle, 1025, 1026.

A person with the hereditary tendency would be in very little danger if living under good hygienic conditions, 1065.

Tuberculous Food.

Has not seen cases where a patient has contracted the disease from tuberculous food; a tubercular disease very often comes on at a rapid rate, but far more often slowly, 1021–4.

There is more liability of danger in milk than in meat, especially with children, 1027–9.

The comparative frequency of cases of abdominal tuberculosis suggests that the disease has started in the alimentary canal, which has been invaded by infective matter. This might be caused by drinking tuberculous milk, 1030–5.

BARLOW, Dr. THOMAS—*continued.*

A great many children, especially of the poor, are brought up on very little milk, but mainly on other substances ; the resultant disease is the same tuberculous disease (as that brought about by infected milk), 1036–44.

Tuberculosis amongst the London poor children is very common indeed, and it is alleged that the disease is common amongst the dairy cows in London, 1045–8.

Milk should be boiled as a precautionary measure (this is done in the hospital), 1049–56.

Whatever measures may be taken with regard to food, there is always the danger from insanitary conditions of life, which (as does an hereditary tendency) predisposes individuals to the attack of disease. Healthy people would be less susceptible, 1057–64, 1066.

Tuberculous Disease of Children.

The tuberculous diseases of children may be divided into two groups. Firstly, those cases beginning in the abdomen with predominant disease in the mesenteric glands, these bear specially upon "milk infection." The second group is of cases where disease begins in the chest cavity, following acute disease. These bear specially upon unhealthy conditions of life. Measles is often followed by tuberculosis, 1070–2.

Tubercular meningitis should not be considered a separate class of disease, 1073–6.

Tuberculous disease of the bones may be either a primary or secondary complaint, 1077–8, and of the lungs in children generally a secondary complaint, 1080–1.

In such cases as those where tuberculosis follows upon measles, the lung may be regarded as being directly infected by the inhalation of the bacillus, 1082–4.

In some cases the mesenteric glands are very largely affected, whilst the damage to the lungs has been very slight; in others the bronchial glands and the mesenteric glands have been seriously affected with little tuberculous deposit in the lungs, 1085–91.

Has very often found general tuberculosis in children under 12 months of age where abdominal tuberculosis only would be expected, 1093–5. Has discovered tuberculosis in an infant of four months old, 1096–7. These early cases can hardly be due to congenital tuberculosis, but the children may have tubercular deposits in them which would be disseminated or not according to the conditions under which they live, 1096–1103, 1114–9. The parents may at a former period have had some tubercular deposit, 1104.

By post-mortem examination it is possible to tell where the disease commenced, 1106–10.

Statistics from hospital post-mortem examinations would in a broad way show the predominance of disease in one group of organs or other, 1111–3.

BOARD OF AGRICULTURE DEPARTMENTAL COMMITTEE UPON TUBERCULOSIS :

Summary of evidence given by Dr. Littlejohn before, *Littlejohn*, 1430–7.

Witness was a member of the Committee, *Horsley*, 1583–90.

BROMPTON HOSPITAL :

Sanitary precautions taken at, *Powell*, 1198–204.

Tubercular spores found in the dust in the hospital, *Klein*, 898–904.

The mortality of those employed at the hospital is quite within the average of ordinary mortality, *Powell*, 1205.

BUTCHERS :

Evidence given on behalf of butchers. *See* Watson, Myers, Smith, Lister, and Hill.

CARNIVORA. *See* ANIMALS ; Susceptibility.

CATS. *See* ANIMALS ; Susceptibility, &c., and *see also* INQUIRY III.

CATTLE. *See* ANIMALS.

CATTLE SHEDS :

Cattle sheds should be regularly inspected, and persons suffering from tuberculosis should not be permitted to serve in cowsheds, *Dreschfeld*, 114, 145–6, 167 ; *Squire*, 991–4.

The larger number of tuberculous animals owe their condition to their inadequate stabling, *Littlejohn*, 1463–76.

The importance of good hygienic conditions. *See* SANITATION.

CHILDREN, DISEASES OF :

A great many children contract mesenteric diseases from their mothers' milk, *Squire*, 949.

An examination of a number of cases of children suffering from tabes mesenterica has shown the origin of the disease to have been in the alimentary tract or glands, *Woodhead*, 231–4.

Comparative extent of tabes mesenterica in children, *Woodhead*, 376.

Tabes mesenterica is a form of tuberculosis arising from ingestion (of tubercular matter, milk, &c.), *Klein*, 559–61.

Classification of tuberculous disease in children, *Barlow*, 1070–95.

Case of tuberculosis in a child of four months of age, not due to congenital disease, *Barlow*, 1096–119.

Forms of tuberculous disease in children, *Goodhart*, 1375–7, 1382–4, 1930–93, 1395–418.

See also Hereditary Tuberculosis and Milk.

COMMUNICABILITY OF TUBERCULOSIS :

The disease is communicable, *Squire*, 926–7 ; *Ransome*, 1232–45 ; *Powell*, 1129–30.

But it is not infectious from one patient to another, *Goodhart*, 1359.

German physicians are strongly impressed with the contagiousness of the disease, *Powell*, 1156–60.

The emanations from an infected patient may be dangerous, *Ransome*, 1280–1.

Bacilli found in a patient's breath and in hospital air, *Ransome*, 1327–29.

Cattle might contract the disease from tuberculous attendants, *Dreschfeld*, 167 ; *Littlejohn*, 1581–2.

COMPENSATION :

There should be a system of compensation for condemned cattle, *Watson*, 1783–8 ; *Lister*, 1894–1916.

All obviously diseased meat should be condemned without compensation, *Lister and Hill*, 2014–25.

There might be a system of insurance supported by the farmers, with contributions from the rates and taxes, *Woodhead*, 316–17, as there is in Copenhagen, *Woodhead*, 286–93. *See also* COPENHAGEN.

The irritation caused by the rigorous inspection, amongst the meat traders is due to the lack of compensation, *Littlejohn*, 1453–5.

The vendors, in the first place, of the cattle cannot be forced to give a warranty of soundness, *Lister*, 1975–92, 2026–8.

CONDEMNATION OF TUBERCULOUS FOOD. *See* INSPECTION.

CONGENITAL TUBERCULOSIS. *See* HEREDITARY TUBERCULOSIS.

CONSUMPTION (OF THE LUNGS) :

Definition of the disease doctors commonly understand when they speak of consumption of the lungs in a human subject, *Klein*, 744–52. *See also* Tuberculosis.

COOKING FOOD AS A PRECAUTION AGAINST INFECTION :

The ordinary modes of cooking meat and boiling milk afford a sufficient guarantee against infection, *Dreschfeld*, 111–12, 120, but flesh, at the centre of a joint, would not be always sterilised, *Woodhead*, 260–5.

Roasting would not much interfere with the infectivity, but the boiling of meat and milk would probably do so, *Horsley*, 1622–8, *Klein*, 595–8.

Cooking will not always destroy the infectivity of food, *Squire*, 960–3.

Tuberculous meat should be well cooked if it is to be eaten, *Ransome*, 1325–6.

In Copenhagen meat is more thoroughly cooked, *Woodhead*, 377–8*a*.

COOKING FOOD AS A PRECAUTION AGAINST INFECTION—*continued.*

Milk should be boiled, *Ransome,* 1250–3, 1311–3, *Goodhart,* 1419–21, *Barlow,* 1049–56. (This is not a necessary precaution, *Powell,* 1135–9.) Such boiling of milk is a common and successful practice in Germany, *Dreschfeld,* 120–7.

There is not much danger in tuberculous milk if it is boiled, *Goodhart,* 1419–21.

COPENHAGEN:

(1) *Meat Inspection in.*

The regulations were instituted in Copenhagen by a local Act of Parliament in consequence of the prevalence of tuberculosis in Denmark, *Woodhead,* 296–301.

The meat is placed in two classes, (1) that killed in Copenhagen, and (2) that killed without and brought into Copenhagen.

With regard to that killed in Copenhagen, a most searching examination of the carcases is made by the inspectors; if general tuberculosis is discovered the whole carcase is destroyed, it may be boiled down to be used in the manufactory of soap, but it is not permitted to reach the food supply; if it is only partly tuberculous, and there is no evidence of rapid spread of the disease, they pass the unaffected portions, *Woodhead,* 271–9.

The inspectors wish for an extension of their powers. Their proceedings are controlled by an Act of Parliament, and they are willingly submitted to by the population, *Woodhead,* 280–5, 328–34.

In 1885 15 slaughtering cells were instituted and hired by butchers. If the cells were used, the meat was inspected and stamped; they were sought after by the butchers, who started a mutual insurance system, *Woodhead,* 286–93.

There is at Copenhagen a general slaughter-house for the meat killed within, and at the railway station a central office where all the meat killed without. Copenhagen is examined, *Woodhead,* 308. All the meat is examined and marked, the stamps being of four classes: 1st class, for meat from Animals slaughtered in public abattoirs, and all parts being sound; 2nd class, Animals slaughtered without the city, all parts being sound; 3rd class, Animals slaughtered at the public abattoirs, parts of which were affected and destroyed; 4th class, Animals slaughtered outside, parts of which were affected and destroyed, *Woodhead,* 310–13.

The second class meat (3 and 4) is not sought after by the consumers, *Woodhead,* 335–6.

The owners of the cattle insure themselves against loss by paying at the abattoir a premium, varied according to the animals slaughtered, *Woodhead,* 318–24.

The percentage of calves condemned is small, as is that of sheep. About 17 per cent. of all the cattle brought in are found to be infected, *Woodhead,* 324–8, 346–50. *See also* Statistical tables, *Woodhead, page* 20 *et seq.*

The prices for (*a*) the inspection at the railway stations, and for (*b*) the use of a well-equipped public abattoir and inspection, are the same. The system pays its own expenses, *Woodhead,* 313.

The authorities say the advantages derived from the system cannot be overrated, *Woodhead,* 294, 295.

(2) *Milk Inspection in Copenhagen.*

There is a voluntary association which does an immense business in the city. All the milk sent in by the farmers is perfectly inspected, the tuberculous milk is condemned, and the owners are compensated whilst there is any doubt, *Woodhead,* 381–94.

Ability and education of inspectors in Copenhagen, *Woodhead,* 415–28.

COWS. *See* ANIMALS.

CRIMINALS, EXPERIMENTS ON. *See* EXPERIMENTS.

DAIRIES:

Witness has no doubt that nearly all the dairy cows in England are more or less infected with tuberculosis, *Littlejohn,* 1508–13.

The greater part of the milk and dairy products in this country are free from any inspection whatever, *Dreschfeld,* 83, and they are possible sources of danger, *Dreschfeld,* 151–5.

DAIRIES—*continued.*

More or less, all the cows in the Edinburgh dairies are infected, no doubt due to insanitary housing, but the sheep and cattle on the farms away from Edinburgh enjoy better ventilation, and thus greater immunity from disease, *Littlejohn,* 1499–521.

A great deal of tuberculous disease springs from dairies, *Lister,* 1949.

The laws as to dairies should be strengthened on general grounds, *Ransome,* 1254–9, 1287.

DEFINITION OF TUBERCULAR DISEASES. *See* TUBERCULOSIS.

DEMERARA (GEORGE TOWN):

"Consumption" is on the increase in the Colony, nearly 1,000 deaths occur annually in the public hospital, 25 per cent. of these being from phthisis and acute tuberculosis, *Williams,* 673–86.

In the majority of cases the disease was contracted through inhalation, *Williams,* 687–99. Scarcely any meat or milk (the latter always boiled) was used in the colony, *Williams,* 700–43.

The inhabitants eat little meat, and do not (except the coolies) use much milk. Thus their tuberculosis is mainly contracted through inhaling the products of previously existing cases, *Williams,* 687–743.

Comparative liability of negroes and East Indians to contract the disease, *Williams,* 727–32.

DIAGNOSIS OF TUBERCULOSIS:

Suggested methods of diagnosis upon living animals, *Horsley,* 1677–80, *Woodhead,* 536, 537.

Value of Dr. Koch's method, *Littlejohn,* 1535–7. *See also* APPENDIX, INQUIRY I. Part III.

DOGS. *See* ANIMALS, SUSCEPTIBILITY.

DRESCHFELD, Dr. JULIUS, M.D., F.R.C.P., London, Professor of Pathology in the Victoria University, and Physician to the Manchester Royal Infirmary. ANALYSIS OF EVIDENCE OF.

Has paid attention to the question of tuberculosis, 1–5.

Has conducted about 20 experiments on rabbits by inoculation from meat from 10 animals condemned by the market inspector as unfit for human consumption; the meat of four of these animals was self-evidently unfit for consumption, and the lungs of all were infected with tuberculosis, 1–19, 94–100, 178–90. Four rabbits inoculated with this meat developed tuberculosis in three to five weeks, 31–33, 92, one inoculated with meat of questionable appearance developed tuberculosis in two or three months, 20. Of five rabbits inoculated with meat of healthy appearance, one developed tuberculosis in 2½ months, the others remained well, 28, 94, 95, 128–9.

Infected meat had no effect upon two dogs, 39; dogs and cats are not susceptible to the disease, 131, but tuberculosis in dogs has been met with, 174–6.

Has formed the opinion that meat appearing healthy was not incapable of conveying tuberculosis, and therefore carcases should be inspected in the slaughterhouse before going to the butchers' shops, 47–50, 51–9, but the danger of contracting tuberculosis from eating tuberculous animals is not great, 58, 61, 107–10, 156–74.

The risk from apparently healthy imported meat is also small, 60–3.

Has not known of a case of tuberculosis being contracted from eating tuberculous meat, 168, 170.

Where the disease is in the pleura and peritoneum, it would be dangerous to eat the meat; where the membranes had been removed it would scarcely be possible to detect the existence of tuberculosis, 134–40.

The inspection of meat by a veterinary surgeon is preferable to the inspection by an ordinary market inspector; it would be wider and more searching, but the provisions of the Public Health Act, properly carried out, would relieve the public of any fear of infection, 65, 71.

Tuberculosis of the mesenteric glands might be contracted by young children from drinking milk obtained from tuberculous cows, the greater part of the milk and dairy produce is not controlled by inspection, 74–83.

DRESCHFELD, Dr. JULIUS—*continued.*

Milk should be boiled, as it is in parts of Germany, to lessen the chance of infection, 120–7.

In Manchester there are no private slaughterhouses, and the owners of animals known to be suffering from tuberculosis cause them to be slaughtered elsewhere, and so bring only dead meat into the town, 84, 87.

The inspection in Manchester is quite efficient, 101–6.

The ordinary modes of cooking meat and boiling milk afford a sufficient guarantee against infection, 111, 112.

There is in man and animals an hereditary tendency to tuberculosis, 116.

Tuberculosis in man and animals is identical, 165.

In human beings about half the cases of tuberculosis are acquired (mostly by inhalation), the rest are hereditary, 202–11.

Animals in the open air are less liable to the disease than those herded together; pigs are liable to it from their habits, 119.

Cattle and cattle-sheds should be regularly inspected, and persons suffering from tuberculosis should not be permitted to serve in cowsheds, 113–19, 145–67.

There is also the risk of acquiring the disease from poultry, which are very prone to tuberculosis, 147–50.

Supposing there were rigid milk and meat inspection, there would still be danger from foreign and dairy produce, 151–5.

Emaciated and lean-looking animals would most probably be tuberculous, 158–64.

Tuberculosis in the rabbit was found especially in the peritoneum and mesenteric glands, 89–92. So it is with children, 170–3. In most acquired cases the mesenteric glands in children and the lungs in adults are affected, thence the whole system, 191–203.

EDINBURGH:

Describes the action of the inspectors of meat in Edinburgh and the consequent irritation amongst the cattle traders, butchers, &c., *Littlejohn*, 1437–53.

Describes a recent clearance of cow-houses in Edinburgh, a slaughter of cows under the pleuro-pneumonia order revealed the extensive prevalence of tuberculosis, *Littlejohn*, 1463–7.

The present and proposed future system of inspection and general dealing with the disease in Edinburgh, and the susceptibility of various animals in and about Edinburgh, *Littlejohn*, 1490–1506, 1527–43, 1565–9, 1573–82.

Statistics of tuberculosis in Edinburgh, *Littlejohn* (*end of evidence*).

Witness considers that the inspectors in Edinburgh, have exceeded their duties, *Watson*, 1699–1748.

The inspectors confine their operations to the slaughter-houses and public meat market, *Watson*, 1726–36.

EXPERIMENTS:

Upon rabbits, to test the infectivity of certain meat, *Dreschfeld*, 1–129; *Woodhead*, 399–404.

Demonstrating the existence of tubercle bacilli in cow's milk, *Woodhead*, 235–7.

Disease produced by experimental inoculation, *Klein*, 625–26.

Experiments as to communicability, *Squire*, 962–73.

Experiments on dogs and cats, *Dreschfeld*, 39, 41.

Experiments referring to the protection given by the inoculation of virus from tuberculous animals, *Klein*, 664–5; experiments with phthisical sputum, *Ransome*, 1268–71.

The methods used of introducing the bacilli into the experimental subject, the results, and the difference of potency of the bacilli from different sources and upon different subjects, *Klein*, 816–24, 830–3. (*See also* Inquiries I., II., and III. Appendix.)

The value of Experiments on Animals applied to man.

The danger of tuberculous food to man may be demonstrated by experiments on animals, *Klein*, 875–82.

The analogy of experiments on animals and man, *Horsley*, 1607–22, 1639–52; safe conclusions with respect to man cannot be fairly drawn from single experiments upon animals, *Littlejohn*, 1547–62.

Tuberculosis in man and animals is sufficiently identical to trust the analogies that may be drawn from the experiments on the lower animals and applied to man, *Powell*, 1170–9.

EXPERIMENTS—*continued.*

Experiments on Criminals.

Value of such experiments, *Littlejohn*, 1481–2; 1549–62.

A great number of experiments on criminals would be necessary for safe conclusions to be drawn, *Horsley*, 1643–52.

Impossibility of such experiments, *Klein*, 625–6.

FOOD, TUBERCULOUS:

Danger of Tuberculous Food.

The milk and flesh of tuberculous animals would be dangerous food, since the bacilli may be deposited in the marrow of bones, the blood, and muscles, *Klein*, 562–78, 615–24, 666–7.

Such tuberculous matter should be condemned; the healthy appearance of meat does not guarantee its freedom from tuberculosis, *Klein*, 579–81.

It may be concluded from experiments that tuberculous food is dangerous to man, and even to perfectly healthy persons, *Klein*, 605–7, 875–82.

There is not much risk in tuberculous food, but, as such, it should be condemned, *Powell*, 1149–55, and there is sufficient danger to call for precautionary measures, *Horsley*, 1592–4, 1653–76.

Cases of the disease being contracted through tuberculous food have not been met with, *Barlow*, 1021–4; *Goodhart*, 1364–9; *Myers*, 1864–9; *Powell*, 1131–4; *Squire*, 942–5, but there is a possibility and suspicion of such cases, *Ransome*, 1244–9, 1250–1. (Neither have cases of disease, contracted from the meat of animals suffering from pleuro-pneumonia been met with, yet such animals are condemned under the Contagious Diseases of (Animals) Act, *Littlejohn*, 1456–64.)

Milk is more dangerous than meat, *Barlow*, 1027–9; *Horsley*, 1592; *Myers*, 1843–5; *Squire*, 995–1001, and poultry and rabbits may be as dangerous as meat, *Horsley*, 1629–63; *Watson*, 1780–2.

Case of disease acquired from tuberculous fowls, *Horsley*, 1635.

Suggested system of first and second class shops for the sale of perfectly good meat and of good meat from tuberculous animals respectively, *Littlejohn*, 1454–7.

There is such a system in Copenhagen. *See* Copenhagen (1).

The frequency of abdominal tuberculosis suggests ingestion as the mode of infection, *Barlow*, 1030–5. A small amount of tubercular disease might be due to the ingestion of tubercular meat, but there are many other important factors. *Ransome*, 1292–1319.

See also Meat and Milk.

Means of rendering tuberculous food harmless *See* Cooking.

GLASGOW:

Action taken to prevent the supply of poor and possibly dangerous meat, *Watson*, 1739–42.

GOODHART, Dr. JAMES FREDERICK, M.D., F.R.C.P., Physician to Guy's Hospital, and Consulting Physician to the Evelina Hospital for Children. Analysis of Evidence of.

Past experience, &c., 1348–58.

"Consumption" is not infectious from one patient to another, 1358*a*, 1359; but the modern view favours the communicability of the disease, and tuberculosis in man and animals is probably identical, 1360–3.

Tuberculous Food.

Has not met with cases of the disease being acquired from tuberculous food, but it might be acquired by an hereditary tendency to disease, but not without the entrance of the bacillus *ab extra*, 1364–9. On general grounds, milk should be boiled and the sanitary laws strengthened, but not with a view to diminish tuberculosis, and any decrease in the amount of the disease should be attributed to general conditions, 1370–4.

There are no special precautions taken at Guy's with reference to tuberculosis, 1404–13.

There is not much danger in tuberculous milk if it is boiled, 1419–21.

The absence of tubercle in the muscles of meat would not guarantee the absence of the disease in the animal, 1422–7.

GOODHART, Dr. JAMES FREDERICK—*continued.*

Diseases of Children.

The disease in children is often a general one of the glands, and if due to a bacillus, it must have spread from the seat of inoculation, and the disease would be expected to appear earliest at the point of inoculation, 1375–7.

Tuberculosis often follows upon whooping cough, and acutely when there is a family history of disease, 1389, 1390; it also follows measles, bronchopneumonia, and intestinal catarrh, 1391–3.

In children the formation of large masses of tubercular disease is more common than in adults; it is a general proposition that, in cases of chronic lesions of a tuberculous nature, the tuberculosis consisted primarily of the change in the glands resulting in caseation, and the infiltration of this matter by the tubercle bacillus is the foundation of tuberculosis, 1395–9.

The disease, in children, of the glands is often non-tuberculous to start with, and this is favoured by hereditary or unfavourable conditions; tuberculosis of the lungs starts in and spreads along those parts that are most feeble in their movements, 1400–3.

Mesenteric disease in children, in connexion with caseous glands, is not necessarily tuberculous nor contains bacilli, 1415–18.

The bacillus is not a necessary constituent of caseous glands, but probably the latter lead to the development of the former; an antecedent condition is necessary to enable the bacillus to take root, 1378, 1379. From experiments it seems likely that tuberculous matter, sufficient to enable a person to take the disease, is very widely spread, 1380, 1381.

In adults, a simple tuberculous ulceration of the intestines without any glandular tuberculous condition is common, but in children uncommon, 1384.

The relation between a disease affecting the mucous membrane of the lung and a disease in the mediastinal glands, 1385–8.

Is of opinion that the bacilli are in everyone, and only want a susceptible condition to take root, 1393, 1394.

GUY'S HOSPITAL:

There are no special precautions taken at this hospital, with respect to tuberculosis, *Goodhart*, 1404–13.

Evidence given by Dr. Goodhart, Physician to Guy's Hospital. *See* Goodhart.

HERBIVORA. *See* ANIMALS; Susceptibility.

HEREDITARY TUBERCULOSIS:

(1) As a general rule the disease in man is hereditary, and also the majority of cases in cattle, *Dreschfeld*, 115, 205.

Inheritance may be a means of contracting tuberculosis, *Klein*, 549–56.

In human beings about half the cases of the disease are acquired (mostly by inhalation), the remainder are hereditary, *Dreschfeld*, 202–4. The child of tainted parents may inherit the seeds of disease or a predisposition towards infection, but the child of healthy parents must contract the disease by infection, *Klein*, 599–604, 635–9.

It is possible for an individual to inherit the germs of disease, and to be free from disease, even to the age of 25 or 30 years, *Klein*, 640–4, 654–6; pulmonary tuberculosis would develop itself in about 20 years after birth, *Klein*, 657–9. Baumgarten states that where tuberculous food is efficiently inspected, there cannot be much danger from this source, and that inhalation does not cause much infection, therefore the great part of existing tuberculosis among human beings in Germany must be hereditary; there are no reliable statistics of inherited disease, *Klein*, 841–61.

It would be possible for an individual, who never manifested symptoms of tuberculosis, though possessing it in a latent form, to pass it on to his or her children, *Klein*, 905–9.

About 48 per cent. of the patients in Brompton Hospital have an hereditary history, *Powell*, 1180–92.

The child of a tuberculous mother acquires phthisis later than the child of a tuberculous father, *Powell*, 1160–7.

HEREDITARY TUBERCULOSIS—*continued.*

(2) *Inherited predisposition to Tuberculosis.*

Hereditary predisposition is an inherited weakness which makes the individual more liable to the attack of the bacillus, once admitted, *Squire*, 935–8.

A susceptible constitution may be inherited, *Woodhead*, 351–5, 430–56.

There is in man and animals an hereditary tendency to tuberculosis, *Dreschfeld*, 116; *Barlow*, 1025–6.

The weak condition of an animal's parents would increase its susceptibility to disease, *Klein*, 866–74.

Children of tuberculous parents would be susceptible, but would not necessarily become tuberculous, *Squire*, 939–41.

Evidence pointing to the reality of an inherited predisposition, *Powell*, 1193–7.

A predisposition is inherited, but there must be an entrance of the bacillus to bring on tuberculosis, *Ransome*, 1320–2.

The hereditary tendency cannot be prevented; tuberculous persons cannot be prevented from marrying, *Littlejohn*, 1570–2.

(3) *Inherited Disease.*

Inherited or congenital tuberculosis is very rare, but an inherited or acquired predisposition to tuberculosis is common, *Woodhead*, 351–9, 430–56; *Squire*, 935–8; *Ransome*, 1320–2.

In animals the disease is directly transmitted, but not in many cases, *Klein*, 645, 646; instance of this in calves, *Klein*, 647–53.

There has been evidence of inherited tuberculosis and cases of congenital disease in young children, and of latent disease in persons even of 30 years of age, *Klein*, 840.

It has generally been asserted that only a taint is inherited, but the bacilli have been found in organs whence the disease might be directly inherited; instance of inherited disease in poultry, *Klein*, 841–58.

The virus is actually handed down from parent to child, but may remain latent for many years, and be brought out by a blow, *Horsley*, 1595–1606, 1639–41.

HILL, Mr. WM. HENRY, representing the Sheffield Butchers' Association. Analysis of Evidence of. *See* LISTER.

HORSLEY, PROFESSOR VICTOR, F.R.S., F.R.C.S., Professor of Pathology at University College, London, Superintendent of the Brown Institution, and Assistant Surgeon to University College Hospital. Analysis of Evidence of.

Was a member of the Departmental Committee on Tuberculosis, 1583–90.

Tuberculous Food.

The tuberculous disease in poultry is the same as in man and cattle; it is very prevalent, and it attacks most commonly the throat, mouth, gullet and liver; the internal part of the fowls may be a source of danger, even as dangerous as tuberculous meat; quotes a case of tuberculosis being acquired from fowls, 1629–38, 1655, 1659–63.

There is considerable liability of danger in the consumption of tuberculous milk, more so than of tuberculous meat, but there is sufficient in the latter, and in meat from tuberculous animals, to call for precautionary legislation, 1592, 1594, 1653–5, 1665–76.

There would also be danger from imported dead meat, 1656–8.

Frozen meat could be easily detained for experimentally determining whether it were tuberculous, 1688.

Mere roasting meat before a fire would not insure the destruction of the virus; boiling the meat or milk might be satisfactory, 1623–8.

In inoculation experiments the extent of disease produced would be in proportion to the amount of bacilli inoculated, 1593.

Inoculation is a strict test for tubercle; the animals that would be best experimented upon are rodents and pigs, 1607–22.

Experiments on the lower animals would be satisfactory in relation to the possible effect upon man with the same kind of food, but a great number of experiments upon criminals, if such a thing were

HORSLEY, PROFESSOR VICTOR—*continued.*
feasible, would be necessary to draw safe conclusions, 1643–52.
The chance of direct infection from person to person is not so great as that which arises from inhalation; the virus is actually handed down directly from parent to child, but may remain latent and be brought out by a blow even after many years, 1595–1601, 1604–6, 1639–41.
Reason for the generalisation of consumption as compared to the localisation of scarlatina, 1602.
There can be no tuberculosis without the entrance of the bacillus into the body, 1603.

Diagnosis of Disease.

Two methods of making a diagnosis of disease in living cattle would be, firstly, by collecting the mucus from the suspected animal and using it in inoculation experiments, secondly, by inoculation with Dr. Koch's tuberculin, 1677–80.
The stamping out of the disease in cattle would mean the slaughter of 5 per cent. of the cattle, and all tuberculous cattle should be killed; the disease in fowls is usually so acute that in its early stages the affected fowl could be slaughtered, 1681–7.
This would produce a perceptible diminution of consumption in man, and especially in children, who have less resisting power than adults, 1689–98.

IDENTITY OF HUMAN AND BOVINE TUBERCULOSIS.
Human and bovine tuberculosis are identical, but the latter is more virulent, *Dreschfeld*, 165; *Woodhead*, 219–30; *Squire*, 926–34; *Powell*, 1127–30; *Goodhart*, 1362–3; *Horsley*, 1630; *Klein*, 538–49, 574.

IMPORTED MEAT:
There would be danger from imported dead meat, *Horsley*, 1656–8; *Dreschfeld*, 151–5.
The home supply has been supplanted by foreign supply in consequence of the rigorous inspection, *Watson*, 1771–807.

INFECTIVITY OF TUBERCULOUS FOOD. *See* FOOD, TUBERCULOUS MEAT, and MILK.

INGESTION, CONTRACTION OF TUBERCULOSIS BY. *See* FOOD, TUBERCULOUS MEAT, and MILK.

INHALATION, CONTRACTION OF TUBERCULOSIS BY.
In large towns, streets, workshops, &c., where many people congregate, there will be found a good many tubercular spores (liable to be inhaled), *Littlejohn*, 1480–8; *Klein*, 794–7, 898–904.
No bacilli have been found in the dust or air of the Manchester Hospital, *Ransome*, 1327–36; but they have been discovered in the Brompton Hospital, *Klein*, 898–902.
There is a greater liability to contract the disease through inhalation than through feeding upon tuberculous material, *Squire*, 970–90.
Herbivora suffer more than carnivora, suggesting that inhalation is a greater source of danger than ingestion, *Squire*, 983–4.
Human beings contract the disease by inhalation or ingestion, *Woodhead*, 356–9.
In human beings about half the cases of tuberculosis are acquired, and of these most by inhalation, *Dreschfeld*, 202–11.
The majority of patients, in Demerara, acquired the disease by inhalation. *See* DEMERARA.
The existence of the bacilli in the atmosphere. *See* ATMOSPHERE and BACILLI TUBERCLE.

INOCULATION:
Experimental inoculation with the virus from tuberculous animals to test its power of conferring immunity, *Klein*, 664–5.
Results would be in proportion to the amount of bacilli introduced, *Horsley*, 1593.
Inoculation is *the* test for tubercle, *Horsley*, 1607–22. *See also* INQUIRIES II. and III.
Inoculation with Dr. Koch's tuberculin as a means of diagnosis in the living animal, *Horsley*, 1677–80.

INSPECTION:
Of meat and milk in Copenhagen. *See* COPENHAGEN.

(1) *Proposed Inspection.*

There must be a rigorous inspection, *Myers*, 1870.
The meat should be examined before it reaches the shops, and if there is no evident disease it should not be condemned, *Watson*, 1734–9.
Good meat, even from tuberculous animals, should not be condemned, *Watson*, 1811–22, 1829–33.
All obviously diseased meat should be condemned, *Lister*, 2014–25.
The Copenhagen system might be carried out in Great Britain. All meat should be inspected and marked, *Woodhead*, 296–306, 309.
There should be established a prohibition against the use of meat from oxen, cows, and swine, unless it is sold under a system of public inspection, and certified, *Woodhead*, 314–6.
There might be a system of mutual insurance among the farmers, &c., with contributions from the rates and taxes, *Woodhead*, 317.
As meat, apparently healthy, is not incapable of conveying tuberculosis, carcases should be inspected in the slaughter-house, *Dreschfeld*, 47–9.
And all tuberculous animals should be condemned, *Woodhead*, 405–10.
There would have to be maintained as large and as skilful staffs of inspectors as in Copenhagen, *Woodhead*, 415–29, 487–91.
The inspection of slaughter-houses and imported meat would be no small matter, *Woodhead*, 478–86, 494–510.
Suggested system of inspection, *Klein*, 885–93.
Such systems of inspection might be welcomed by the meat trade, *Woodhead*, 512–3.
Means of diagnosis of the disease in the living animal. *See* DIAGNOSIS, &c. and ENQUIRY I.
The same regulations should apply to rabbits and poultry, *Watson*, 1780–2.

(2) *Value of the proposed Inspection.*

Such inspection of meat and milk would in time cause a considerable decrease in the amount of the disease, but it would not eradicate it, *Woodhead*, 360–3, 395–7; *Littlejohn*, 1477–8; *Horsley*, 1689–98.
There would still be danger from foreign and dairy produce, and from other means, inhalation, heredity, &c., *Dreschfeld*, 151–5.
Theoretically the disease might be stamped out, *Woodhead*, 528–35.
But this would mean the slaughter of 5 per cent. of the cattle in the kingdom, *Horsley*, 1681–7.
Great mischief may be done by hasty and superficial examination, *Watson*, 1808–10.

(3) *Effect of past Inspection.*

Encouragement has been given to the inspectors by the discoveries of the last five or six years, and they are now more rigorous in their condemnation, though they have no specific power under the Acts, *Littlejohn*, 1437–52, 1470–6.
The consequent irritation in the meat trade is due to the lack of compensation, *Littlejohn*, 1453–5.
Alleged undue condemnation or over-zealous inspection, *Myers*, 1848–9; *Watson*, 1708–25.
The local authorities refuse to provide an inspection, not wishing to be held to guarantee the meat, *Watson*, 1770.
The strict inspection has occasioned a withdrawal of a great amount of good meat from the supply, *Watson*, 1750–69; and the foreign supply has to some extent supplanted the home supply, *Watson*, 1771–807.
Animals from Canada and United States are inspected in Glasgow, *Watson*, 1834–8.
The original functions of the inspectors, under the Public Health Act, were to put aside putrid and over-kept meat, and diseased meat is included under these headings, *Watson*, 1740–8; *Myers*, 1850–63.
Witness cannot say whether the amount of tuberculosis has decreased since the inspectors have been more rigid in condemnation, *Klein*, 588–90.
The inspectors have every facility for examining the meat when disembowelled, *Watson*, 1726–33.

INSPECTION—*continued.*

(4) *Inspectors.*

Action of, in Edinburgh. *See* EDINBURGH.

Veterinary surgeons would be preferred to ordinary market inspectors, *Dreschfeld*, 65–73.

The inspectors should gain their knowledge by experience, *Watson*, 1823–8.

Ability and education of the inspectors in Copenhagen, *Woodhead*, 415–28.

JEWS:

The Jews (in South Hungary) have a very effectual system of inspection, *Klein*, 669–72.

Jews, who are most particular with regard to their meat, suffer as much from tuberculosis as do Christians, *Myers*, 1882–5.

KLEIN, DR. EDWARD EMMANUEL, F.R.S., Lecturer on Physiology at St. Bartholomew's Hospital. ANALYSIS OF EVIDENCE OF.

Generally speaking, human and bovine tuberculosis are identical, though the latter is more virulent, 538–48.

Tabes mesenterica is a form of tuberculosis arising in children from ingestion, 557–61.

The dust caused in certain trades brings on, in the workpeople, tuberculosis due primarily to pneumonia, 747–8.

Danger from Tuberculous Food.

The milk or flesh of tuberculous animals would be dangerous food, since the bacilli may be deposited in the marrow of bones, the blood and muscles, 562–78, 666, 667, 615–24.

The healthy appearance of meat does not guarantee its freedom from tuberculosis, 579–81.

Some means should be devised for preventing the exposure for sale of meat that may be dangerous to the public, 582–5.

Cannot say what, if any, has been the decrease in tuberculosis, since the market inspectors had powers of examination and rejection conferred upon them, 588–90.

Tuberculosis is a disease that must be produced by the introduction, in one way or other, of the particular bacilli which produce the infection; it may be inherited, 591–4.

Milk would be more dangerous, since a great deal is consumed in a raw state; roasting would not much lessen the effect of tuberculous meat and milk, but boiling would do so, 595–8.

Perfectly healthy people might contract the disease through eating tuberculous matter, 605–7.

Inoculation of animals with tuberculous matter has produced the disease; experiments cannot be performed on man, 625–6.

It may be concluded, from the results of experiments on animals, that tuberculous food is dangerous to man, 875–82.

A butcher, in the act of trimming off the pleura or the peritoneum, may infect the meat generally. The following method of inspection might be enforced, when the inspector, on the first opening of the carcase, discovers tuberculosis in the lungs: the meat farthest from the lungs should be examined, and, if tubercles are found in it, the whole should be destroyed; in any case such lungs should be condemned. Such a system would greatly upset the meat trade in this country, 884–93. Evidence of the acquisition of the disease by ingestion, 896.

The lung being the most favourable organ for the development of the disease, pulmonary tuberculosis is common, but this does not imply that the disease is caused by inhalation, 834–7. Mesenteric disease in children is usually due to ingestion, 838–9.

Hereditary Tuberculosis.

(i.) *Man:*

Inheritance may be a source of tuberculosis, 549–56.

A weak child, born of tainted parents, may be born with the seeds of the disease in him, or may inherit a predisposition towards infection, but the children of healthy parents must contract the disease by infection, 599–604.

It is possible for a person to inherit the germs of disease, and to go free until he is 25 or 30 years of age, 640–4, 654–6.

It would be possible for a person, who never manifested symptoms of tuberculosis, though having the latent disease, to pass it on to his children, 905–9.

Pulmonary tuberculosis would develop itself in about 20 years after birth, 657–9.

One individual of a species may, another may not, contract the disease through food or inhalation, according to susceptibility, 607–14.

In many cases there has been evidence of probably inherited tuberculosis; there are cases of congenital disease in young children, and of latent disease in persons, even, of 30 years of age, 840.

(2) *Animals:*

In animals the disease is directly inherited, but not in a great number of cases, 645–6.

Quotes an instance of congenital tuberculosis in calves, 647–53.

It has been generally asserted that there is only an hereditary taint, but it has been demonstrated that the bacilli may be present on the mucous membrane of the Fallopian tubes, and has been found in the testes, from which tuberculosis might be directly inherited; there are instances of inherited disease in the offspring of a tuberculous cock; the same has been found as regards cattle and man, a great portion of human tuberculosis being inherited; there are no reliable statistics to show the percentage of inherited tuberculosis, 841–58. It is said that where milk is boiled and, together with meat, efficiently inspected,—as is very necessary,—there cannot be much danger, and that since inhalation does not cause much infection, that the great part of existing tuberculosis must be hereditary, 859–61.

The weak condition of an animal's parents would increase its susceptibility to some diseases, and possibly to tuberculosis, 866–74.

Animals in the Zoological Gardens evidently do not inherit the disease, 910–13.

Jewish Custom.

The Jews (in South Hungary) have an inspector who examines *all* flesh slaughtered; if he suspects that the glands are tubercular he condemns the whole animal; their system is very effectual, 669–72.

Definition of Tuberculosis.

The diseases commonly understood under the head of consumption of the lungs, besides tuberculosis, are those resulting from croupous pneumonia, gangrene, cirrhosis, septic processes in the lungs, and the group of diseases known as broncho-pneumonia, 744, 745.

No disease should be called tuberculosis, unless, by examination or otherwise, the presence of the bacilli could be demonstrated, 749–52.

Describes the symptoms and signs which would point out the existence of tuberculosis, 627–30.

Tuberculosis amongst Animals.

Bovine species are very prone to the disease, then come pigs, then sheep; rabbits and guinea-pigs are shown by experiments to be highly susceptible; poultry and birds are susceptible to a different kind of tuberculosis; monkeys are subject to the disease, 753–8.

It is shown by the reports of the Berlin slaughter-houses that comparatively very few sheep are condemned on account of tuberculosis, 759–69.

As compared to sheep, cattle are very susceptible to the disease, cats and dogs should be in this respect classed with sheep, 770–9.

A great many calves have an early form of tuberculosis (which must have been inherited), but this is not noticed as they are not permitted to grow old enough for the disease to develop and become conspicuous, 780–9.

Tubercle bacilli.

It is quite possible for the tubercle-bacillus to have an existence outside the body, and for the spores thus to exist in multitudes and to retain their vitality, 791, 792.

Tubercular spores no doubt exist in the streets in large towns, and especially in workshops and other such places, where there is a lack of sunlight which is fatal to them, 793–7.

KLEIN, Dr. EDWARD EMMANUEL—*continued.*

The tubercle bacilli are widely diffused in London; they have been found in the dust in the Brompton Hospital, 898–904.

There are two kinds of predisposition or liability to contract the disease, that in the species and that in the individuals of the same species, 798–809.

The presence of tubercle-bacilli in the atmosphere is not sufficient alone to cause infection, a predisponent condition is a very important factor; this has been rather overlooked, 811–5.

As regards the attenuation of the tuberculous virus (from experiments), if rapid and extensive disease is produced, the bacilli are more virulent than where the progress is slower and the disease localised, 660–3.

Experiments.

Experiments made with reference to the protection given by the inoculation of virus from tuberculous animals, 664–5.

The experimental methods of introducing the bacilli have been, by feeding, by inhalation, and by intraperitoneal, intravenous, and subcutaneous injections, and injections into anterior chamber of eye; the third and sixth methods have yielded the most positive results, the next successful method is the fifth, and then the fourth method; the feeding experiments have given results equal to those of subcutaneous injection, the results of the inhalation experiments have been contradictory, dependent on the different methods of experiment, but there is no doubt that infection can be brought about by inhalation, 816–8.

Experimenting with matter from localised tuberculosis would give less rapid results than with matter from disseminated tuberculosis, 819–24; bacilli differ in their virulence, 825, 826; bovine tubercle is more virulent than human tubercle, 827–9; tubercle introduced into one animal and thence to another, and so on, would decrease in virulence; the method of introduction would to a great degree rule the results; in man, as in animals, there is a varying susceptibility to infection, 830–3.

LISTER, Mr. EDWARD, and HILL, Mr. WM. HENRY, representing the Sheffield Butchers' Association. Analysis of Evidence of.

Meat in the first stages of tuberculosis should not be condemned; a tuberculous animal can give meat equal in appearance to the most wholesome meat; perfectly good meat from tuberculous animals has been wrongly condemned; in such cases the butchers should be compensated, 1886–916.

Does not think that meat from tuberculous animals has been productive of the disease in man, 1925–29, 1933–40.

Does not consider the danger from healthy meat from tuberculous animals great, 1917–9, 2004–10; an experienced butcher would reject obviously bad meat, 1930–48.

Is of opinion that tuberculosis in animals springs from dairies, 1949–53, and that there is more danger in tuberculous milk than meat, 2011–3.

Respective ages at which cows and oxen are slaughtered, 1954–68. In cattle the disease is more common in the older animals, calves being rarely affected, 1972–5.

Could not enforce the vendors of cattle, in the first place, to give a warranty of soundness, 1975–92, 2026–8.

Does not admit the conclusiveness of the analogy of experiments upon animals, 1920, 1994–2003.

All obviously diseased meat should be condemned without compensation, 2014–25.

LITTLEJOHN, Dr. HENRY DUNCAN, M.D., F.R.C.S., Medical Officer of Health for Edinburgh and Consulting Medical Officer to the Local Government Board for Scotland (Board of Supervision). Analysis of Evidence of.

Gave evidence before the Departmental Committee on tuberculosis, upon the difficulty of dealing with the question of tuberculosis, what was done in Edinburgh and the question of compensation, 1430–6.

Formerly even manifestly tuberculous meat was passed by the inspectors, but now when the glands are found to be infected the animal is condemned, on the grounds that when the glands or udder are infected the entire animal must be infected; a difficulty arises since the inspectors have no power, under the Public Health Acts, to do this, 1437–49, 1544–68.

The inspectors have received great encouragement and impetus in the discharge of their duties from the discoveries of the last five or six years, 1450–52.

The irritation amongst the butchers and farmers from the action of the inspectors is mainly due to the absence of compensation; meat in the future might be sold in two classes, one quite sound and the other meat from tuberculous animals, 1453–5.

Has not met cases of the disease being acquired from tuberculous meat, nor from meat of animals suffering from pleuro-pneumonia, yet the latter animals are condemned under the Contagious Diseases (Animals) Act, 1456–62, 1563, 1564.

Of 300 cows slaughtered under the clause of the Act relating to pleuro-pneumonia in Edinburgh, 120 were found to be tuberculous, and they were supplying the City, which has a great juvenile population, with milk; a greater percentage of disease occurred where the housing of the animals was insanitary; a limited compensation was granted by the magistrates under the Act, 1463–7. The disease has rapidly spread in Edinburgh (as regards animals) from the disgraceful condition of the cowhouses; they are in as bad a state in the country, 1468–70. Animals might contract the disease from tuberculous attendants, 1581, 1582; hundreds of carcasses are now condemned that would have been passed 10 or 12 years ago, 1476.

An immediate, though gradual decrease in the amount of consumption in the kingdom would follow the prohibition against bringing tuberculous animals into the meat supply, 1477, 1478.

No dead meat reaches the Edinburgh public abattoirs, but it is taken to private dead meat depôts; the Corporation are promoting a Bill to deal with this dead meat in a public clearing-house, 1490–6; thus both the dead and live meat will be safeguarded, 1497, 1498.

Pigs are frequently infected, and sheep, from their open air life, very rarely; more or less, all the cows in the Edinburgh dairies are infected, no doubt due to insanitary conditions of life, but the sheep and oxen, on the farms away from Edinburgh, enjoy better ventilation, and thus greater immunity from disease, 1499–521.

A thorough examination of milk-giving cows during life is desirable, 1531, 1532.

Scotland is behind England with regard to the housing of cattle regulations, 1522.

Enumerates the staff dealing with animal disease in Edinburgh; the inspector in the first place condemns, and at any expression of doubt, a superior officer is called in and so on, 1527–31.

Cannot express an opinion as to the means of discovering the place and mode of entry of the disease in any patient, 1523–6.

The Edinburgh Corporation is promoting a Bill to give the inspectors more power, 1538, 1539.

Dr. Koch's method of diagnosis of tuberculosis has yet to be proven, 1535–7.

The action taken by the Corporation in Edinburgh to better the conditions of life amongst the poor has decreased the amount of disease, though tuberculous food is still consumed, 1565–9.

All animals that were condemned were killed on the ground that they were in contact with pleuro-pneumonia and not on the supposition that they were tuberculous, 1540–3.

The patient, more or less susceptible, must be invaded by the poison—imbibed, injected or inhaled—*ab extra*, to become tuberculous, 1479, 1480.

Experiments might be made upon criminals, as it is not safe to draw conclusions from experiments on animals, 1481, 1482, 1549–62.

Has a suspicion that "consumption" is an infectious disease, expectoration is a medium for the conveyance of infection, and very little care is exercised as to this, 1483–5; if it were not for the resisting strength of the many, the germs, constantly floating in the air, of tuberculosis (as of scarlatina) would clear off the human race, 1486–9.

LITTLEJOHN, Dr. HENRY DUNCAN—*continued.*

When carcasses are sent to a killing-house or depôt the authorities insist upon the offal being brought with them; of course the bad offal may be changed for sound in the course of transmission, 1573–8.

The hereditary tendency to transmission of the disease cannot be limited, 1570–2.

There is no test by which tuberculous meat can be detected, 1579, 1580.

At the end of the evidence "Statistics of Tuberculosis in Edinburgh" *are given.*

LUNGS:

The lungs are the most favourable organs for developing the disease, *Klein*, 834–7.

The lungs are mostly affected, *Williams*, 736–9.

The lungs are first affected where inhalation has caused disease, *Squire*, 946–56.

MANCHESTER:

Evidence given by the physician to the Manchester Royal Infirmary. *See* Dreschfeld.

In Manchester there are no private slaughter-houses, and the owners of animals known to be suffering from tuberculosis cause them to be slaughtered elsewhere, and so bring only dead meat into the market, *Dreschfeld*, 84–7.

MANCHESTER HOSPITAL FOR CONSUMPTION:

The precautions taken in, and the comparative liability of the staff, servants, and outsiders to contract the disease, *Ransome*, 1303–18*a*.

MAN, TUBERCULOSIS IN:

Tuberculosis in man and animals is identical, but there is a slight difference in quality, *Dreschfeld*, 165; *Woodhead*, 219–30; *Squire*, 926–34; *Klein*, 538–49, 574; *Powell*, 1127–30; *Goodhart*, 1362, 1363.

Tuberculosis amongst the Negroes and East Indians in Demerara. *See* Demerara.

Possibility of contracting tuberculosis by inhalation; *See* Inhalation, by ingestion; *See* Food, Tuberculous, Meat and Milk, and *see also* Methods of contracting Tuberculosis; Susceptibility to contract Tuberculosis, and Hereditary Tuberculosis.

Transmission of Tuberculosis. See Communicability, &c.

Diseases in Children. See Children, &c.

Analogy of experiments on animals applied to man. See Experiments. *See also* Tuberculosis.

McFADYEAN, PROFESSOR:

Experiments by demonstrating tubercle bacilli in milk, *Woodhead*, 232–7.

Inquiry I. carried out by Professor McFadyean. *Quod vide.*

MEAT:

(1.) *From Tuberculous Animals.*

Tuberculous animals have not been productive of disease in man, *Lister*, 1925–9; 1933–40.

Has not heard of tuberculosis being acquired through eating tuberculous meat, *Littlejohn*, 1458–62.

Meat is a possible dangerous conductor of the disease, *Horsley*, 1588–94.

There is also danger in imported dead meat, *Horsley*, 1656–88.

Obviously diseased meat should be discarded, *Watson*, 1716–18; and an experienced butcher would reject such meat, *Lister*, 1930–48; *Myers*, 1871–4.

The danger of contracting the disease by eating meat from tuberculous animals is not great, *Dreschfeld*, 64, 107–10, 156–74; *Lister*, 1917–2010; *Powell*, 1143–54; but that meat, even though apparently healthy, is not incapable of conveying tuberculosis, or does not necessarily come from a non-tuberculous animal; the sale of all meat from tuberculous animals should be prohibited, *Klein*, 579–81; *Littlejohn*, 1544–787, *Dreschfeld*, 34, 35, 57–9.

There are no common means of telling whether healthy-looking meat came from a tuberculous animal, *Myers*, 1875–80.

The absence of tubercles in the meat does not guarantee that the animal is free from disease, *Goodhart*, 1422–7.

MEAT—*continued.*

Perfectly healthy people could contract the disease by eating tuberculous matter, *Klein*, 605–13, 625.

Tuberculosis has been produced by using, experimentally, apparently healthy meat, *Woodhead*, 399–404.

The milk or flesh of tuberculous animals would be dangerous food, since the bacilli may be deposited in the marrow of the bones, the blood and muscles, *Klein*, 562–78, 666–7, 615–24.

If the lungs, pleuræ, liver, or glands of the abdomen are found to be diseased, the whole carcase should be condemned; meat should be inspected before it is sent into the market, *Dreschfeld*, 37–57. *See also* Copenhagen.

(2.) *Dead Meat.*

Owners of animals suffering from tuberculosis cause them to be killed elsewhere, and so bring dead meat only into the Manchester market and avoid the rigid inspection, *Dreschfeld*, 86–7.

Some means should be devised for preventing the exposure for sale of meat that may be dangerous to the public, *Klein*, 582–5.

Tuberculous meat should be well cooked before being eaten, *Ransome*, 1325–6.

Meat in the first stages of tuberculosis should not be condemned; a tuberculous animal can give meat equal in appearance to the most wholesome meat, *Lister*, 1886–916.

There is no rough or immediate test by which tuberculous meat can be detected, *Littlejohn*, 1579–80.

See also Inspection and Food, Tuberculous.

Means by which tuberculous food can be rendered harmless. *See* Cooking.

There is established a system of first and second class shops in Copenhagen for the sale of perfectly sound meat from tuberculous animals. *See* Copenhagen, *Meat Inspection.*

Suggested adoption of this, *Littlejohn*, 1454–7.

MESENTERIC DISEASES. *See* CHILDREN, DISEASES OF.

METHODS OF CONTRACTING TUBERCULOSIS:

The disease must be contracted *ab extra*, *Barlow*, 1011–20; *Klein*, 591–4; *Squire*, 926–55; *Littlejohn*, 1479, 1480.

The presence of the bacillus is necessary to cause disease, *Squire*, 926–55; *Horsley*, 1602.

In human beings about half the cases of tuberculosis are acquired—mostly by inhalation—the rest are hereditary, *Dreschfeld*, 202–11.

The means by which tuberculosis is contracted *ab extra*, *Woodhead*, 364–75; it is contracted by the poison (either imbibed, ingested, or inhaled) or by inherited disease or inherited predisposition to disease, *Klein*, 591–4, 599–604; *see also Williams*, 700–43; *Ransome*, 1232–9; *Woodhead*, 356–9.

An insanitary condition of life is more liable to encourage the disease and to increase its virulence than bad food, *Barlow*, 1057–62; *Ransome*, 1260–82, 1336–40.

There is no evidence to trace the acquisition of disease to ingestion or inhalation, *Littlejohn*, 1523–6; disease traced to ingestion, but not inhalation, *Klein*, 894–7.

Some German pathologists believe in the contagiousness of "consumption," *Powell*, 1157–60.

The disease is communicable from man to man, *Squire*, 926–7; *Ransome*, 1232–45; *Powell*, 1127–30; but it is not contagious, *Goodhart*, 1358–63.

By post-mortem examination it is possible to say where the disease commenced, *Barlow*, 1105–10.

It is possible for the bacillus to enter by the intestine and yet the principal manifestation be in the lungs, *Powell*, 1210–3.

Susceptibility is an important factor in infection, *Klein*, 811–5.

See also Hereditary Tuberculosis; Meat, Milk, Food, Tuberculous; Inhalation and Communicability.

Tuberculosis following other diseases, &c.

It often follows upon whooping-cough, and acutely when there is a family history of tuberculosis; it also follows upon measles, broncho-pneumonia and intestinal catarrh, *Goodhart*, 1389–94.

MILK:

Nearly all the dairy cows in Edinburgh are more or less infected with tuberculosis, *Littlejohn*, 1508–13.

Danger of tuberculous milk to young children; it is even more dangerous than tuberculous meat, *Horsley*, 1588–94; *Dreschfeld*, 75; *Powell*, 1132–42; *Squire*, 960–3; *Klein*, 596–8.

Boiling does not necessarily sterilise milk, *Squire*, 961.

The greater part of the milk and dairy products consumed in this country are free from any inspection whatever, *Dreschfeld*, 83.

The existence of tubercle bacilli has been demonstrated in the milk of cows, such milk is capable of conveying the disease, *Woodhead*, 232–59, 410*a*–14, 465–72.

A thorough examination of milk-giving cows during life is desirable, *Littlejohn*, 1532.

System of voluntary milk inspection. *See* Copenhagen.

The danger to a child from feeding on its mother's milk if the mother is tubercular, and from a tubercular cow's milk, *Squire*, 946–56.

Milk is more dangerous than meat, *Squire*, 995–1001; *Powell*, 1140–1.

The disease in animals is common in badly ventilated dairies, and tuberculous milk is more dangerous than tuberculous meat, *Lister*, 1949–2013; *Barlow*, 1033–4; and is especially dangerous to children, *Barlow*, 1036–48.

Milk should be boiled as a precautionary measure, *Barlow*, 1049–56; *Ransome*, 1250–3; 1311–3.

This is not necessary, *Powell*, 1135–9.

If milk were so dangerous more disease amongst children would be expected, *Powell*, 1161–7.

Typhoid fever has originated from milk contaminated with impure water, but clinical experience would point to the negative with regard to tuberculosis, *Powell*, 1142–8.

Milk might become infected by bacilli in dust, *Ransome*, 1341–2.

Wholesale slaughter of tuberculous cows in Edinburgh that supplied milk, *Littlejohn*, 1463–70.

MYERS, Mr. THOMAS, President of the National Confederation of Meat Traders' and Butchers' Associations; representing affiliated associations from Birmingham, Bolton, Bradford, Coventry, Doncaster, Dublin, Edinburgh, Glasgow (Wholesale Butchers' Society), Halifax, Hull, Leeds, Liverpool, Manchester, and Paisley; and SMITH, Mr. J. R., Leeds, Treasurer of the National Confederation of Meat Traders' and Butchers' Associations, and representative of the Leeds Local Association. Analysis of Evidence of.

Milk would be more dangerous than meat. Have not heard of injurious effects being caused by tuberculous food; the danger would be slight in the early stages of disease, 1843–5, 1864–9.

There must be a rigorous inspection, 1870.

The amount of disease has decreased as the sanitation has improved, 1847.

Instance of undue condemnation, 1848–9. In consequence of the greater activity of the inspectors the home supply has been supplanted by the foreign; the imported dead meat escapes inspection, 1850–63.

Evidently diseased meat would never be exposed for sale, 1871–4.

There are no ordinary means of telling whether healthy looking meat came from a tuberculous animal, 1875–80.

The Jews, who are most particular with regard to their meat, suffer from tuberculosis as much as Christians, 1882–5.

PIGS. *See* Animals, *Susceptibility*, &c.

PLEURO-PNEUMONIA:

A recent clearance of animals under a pleuro-pneumonia order in Edinburgh demonstrated that a great percentage of them were suffering from tuberculosis, *Littlejohn*, 1463–7.

POULTRY:

The disease in poultry is identical with that in man and animals, it attacks mostly the throat, mouth, gullet, and liver, and the internal parts of tuberculous fowls would be dangerous as food; case of tuberculosis acquired from poultry, *Horsley*, 1629–63.

POULTRY—*continued.*

The disease in poultry is so acute that it is easily recognisable in its earliest stages, *Horsley*, 1681–7.

Poultry are much more susceptible than cattle and sheep, *Watson*, 1780–2.

See also Animals and Food, Tuberculous.

POWELL, Dr. RICHARD DOUGLAS, M.D., F.R.C.P., Physician Extraordinary to Her Majesty the Queen, Consulting Physician to the Brompton Hospital, and Physician to the Middlesex Hospital. Analysis of Evidence of.

Past experience, 1120–4.

Tuberculosis in man and animals is identical, with a slight difference in quality, and is communicable, 1125–30, but is sufficiently identical to trust the analogies that may be drawn from the lower animals and applied to man, 1170–3. Thus it might be inferred that if a cow's milk did harm to a calf, it would similarly harm a child, 1174–9.

Tuberculous Food.

Has not met with cases of the disease contracted from tuberculous meat or milk, 1131–4. Does not think that the boiling of milk is a necessary recommendation, 1135–9. Milk would be a more probable source of infection than meat, 1140, 1141. Typhoid fever has originated from milk (contaminated with impure water), but as to tuberculosis clinical experience points to the negative; phthisical tuberculosis is very rare in young infants being nourished by lactation, as is tuberculosis of the bowels, 1142–8. There is not much risk in the eating or drinking of tuberculous food, 1149–54; but evidently tuberculous food should be prohibited, 1155.

German physicians are impressed with the contagiousness, man to man, of consumption, but not of animal to man, 1156–60, since raw meat is commonly given to patients, 1168, 1169.

If milk were so dangerous more disease amongst children should be expected; statistics show that the child of a diseased mother acquires phthisis later than that of a diseased father, 1161–7.

Hereditary Tuberculosis.

About 48 per cent. of the patients in Brompton Hospital have an hereditary history; the inheritance in 59 per cent. is on the female side, and 37 per cent. on the male side), 1180–92. This percentage of inheritance would hold good with children, and it strongly points to the reality of inheriting a predisposition to phthisis, 1193–7.

The sanitary precautions taken in Brompton Hospital include the disinfecting of sputa and spittoons 1198–204.

The mortality of the staff and people employed at the hospital is quite within the average of ordinary mortality, 1207.

The place at which the bacilli enter the body cannot be inferred from the local manifestation of the tubercle, 1210–3.

PRECAUTIONS TO BE TAKEN:

All obviously tuberculous material should be destroyed, *Horsley*, 1688; *Lister*, 2014–25; but *see also* Inspection (1) and (2).

The ordinary modes of cooking meat and boiling milk afford a sufficient guarantee against infection, *Dreschfeld*, 111–2, 120; the latter precaution is successfully carried out in Germany, *Dreschfeld*, 121–7, but *see also* Cooking Food, &c.

Necessity of inspecting cattle and their sheds and of preventing persons suffering from tuberculosis from serving in them, *Dreschfeld*, 167; *Littlejohn*, 1581–2.

Though the disease does not frequently spring from tuberculous food, yet, on general grounds, a more stringent administration of the law of inspection is needed, *Ransome*, 1323–6.

To better the insanitary conditions of life is a more necessary precaution against tuberculosis than to make regulations for meat inspection, *Barlow*, 1057–62; *Ransome*, 1282–90; *Squire*, 991–4.

The system in vogue in Copenhagen for milk and meat inspection might with great difficulty be adopted in this country, *Woodhead*, 271–94, 346, 478–521.

Precautions taken at Brompton Hospital, *Powell*, 1199–1209.

Cattle and Cattle Sheds. *See* Slaughterhouses, &c.]

PREDISPOSITION TO TUBERCULOSIS:

Hereditary. *See* Hereditary Tuberculosis (3).

Acquired. *See* Susceptibility.

RABBITS:

Experiments conducted by Dr. Dreschfeld upon rabbits, *Dreschfeld*, 1-19-98-100, 188-9.

Diagram showing the results of the above experiments, *Dreschfeld, end of evidence.*

Rabbits are more susceptible than cattle and sheep, *Watson*, 1780-2.

RANSOME, Dr. ARTHUR, M.D., M.A., F.R.S., Honorary Physician to the Manchester Hospital for Consumption and Diseases of the Throat. Analysis of Evidence of.

Past experience of, 1219-31.

As a general rule the disease must be communicated *ab extra* by inhaling, imbibing, or ingesting the poison, or possibly by inheritance, 1232-9. Attendants on consumptive people and hospital staffs would not be more liable to disease than others, 1240, 1241, 1314-7. This is no doubt due to the perfect ventilation; the bacilli are derived chiefly from the patients' sputum, which becomes dried and carried off in dust, 1261-7, 1303-10.

Animals have contracted tuberculosis by inhaling powdered and dried sputum, 1268-71.

Does not consider the "catching the breath" of a patient as dangerous, but the emanations from an infected patient may be so, 1280, 1281. Has found the bacillus in a patient's breath, but not in the air of the hospital, 1328-9.

Sputum exposed in well-lighted and ventilated place and in a badly-lighted and ventilated place caused respectively negative or positive results, 1334-40.

Tuberculous Food.

Has not met with, but has suspected, cases of meat and milk conveying the disease to man, 1244, 1245. There is a possibility of such cases, 1246-9.

Has experienced cases which could not be accounted for except the assumption of milk infection; the milk in the hospital is always boiled; this is very necessary, 1250-3, 1311-3.

On general grounds the laws as to dairies, cattle, and sanitation should be strengthened, 1254-60, 1282-7. It would be risky to purchase meat from one butcher where it would be safe from another, 1288-91.

A small amount of tuberculosis might be due to the ingestion of tubercular meat, 1292, 1293, but there are vastly more important factors, 1319. Tuberculous meat must be well cooked to be safely eaten, 1325, 1326. Milk might become infected by dust, 1341, 1342.

The bacillus of tuberculosis gains virulence after some little time under certain bad hygienic conditions; there are houses in the low districts of Manchester in such a condition, where the disease constantly occurs, 1272-9.

There has been a diminution of tuberculosis in Manchester, 1292-7.

Hereditary Consumption.

Although possible, directly inherited disease is rare, but a predisposition to the disease is inherited, and infection must arise *ab extra*, 1320-2.

SALE OF MEAT:

The meat should be examined before it reaches the shops, *Dreschfeld*, 47-59; *Watson*, 1734-9.

Suggested system of first and second class shops for the sale of first and second class meat (as in Copenhagen), *Littlejohn*, 1454. *See also* Copenhagen (1).

Some means should be devised for preventing the sale of meat from a tuberculous animal, *Klein*, 582-5.

SANITATION:

Precautions taken at the Brompton and Manchester Hospitals for consumption, and Guy's Hospital. *See* Brompton, Manchester, and Guy's Hospitals.

On general grounds; the sanitary laws should be strengthened, *Goodhart*, 1370-4, *Ransome*, 1254-60, 1282-7.

The decrease in the number of consumptive cases is due to the better sanitary regulations, *Littlejohn*, 1563-9; *Squire*, 985; *Goodhart*, 1370-4; *Myers*, 1847.

SANITATION—*continued.*

Susceptibility is increased by insanitary occupations, *Klein*, 747-8; and the bacillus becomes more virulent under the same conditions, *Ransome*, 1272-9.

Instance of insanitary districts in Manchester, where the disease constantly occurs, *Ransome*, 1272-9.

Healthy persons would resist the attack of the germs in the air, *Squire*, 958-9.

Special vocations in life, special trades, &c. increase susceptibility, *Squire*, 957.

Attendants on consumptive persons and hospital staffs would not be more liable to disease than others, *Ransome*, 1240-1, 1314-7; this is no doubt due to good ventilation, *Ransome*, 1261-7. The mortality of persons employed at Brompton Hospital is no greater than the average mortality, *Powell*, 1207.

A person with an hereditary tendency to disease, if living under good sanitary conditions, would be in no danger of disease, *Barlow*, 1065.

Better conditions of life are more important than good regulations, *Barlow*, 1057-64; *Squire*, 991-4.

A percentage of disease in animals due to insanitary housing, *Littlejohn*, 1468-70.

If sheep—rarely tuberculous—were confined in stables, as are cattle, it is likely they would be found equally tuberculous, *Squire*, 975-82.

SLAUGHTER-HOUSES AND CATTLE SHEDS, DAIRIES, &c.

Slaughter-houses.

To ensure the absence of diseased meat in the market, it is very necessary that the meat should be inspected in the slaughter-houses, *Dreschfeld*, 48-56.

In Manchester there are no private slaughter-houses, *Dreschfeld*, 84-6.

System of public slaughter-houses in Copenhagen. *See* Copenhagen.

Cattle Sheds.

Cattle sheds should be regularly inspected, *Dreschfeld*, 114; *Squire*, 991-5, as the great amount of tuberculous animals owe their condition to their insanitary stabling, *Littlejohn*, 1468-76.

The importance of good hygienic conditions of life. *See* Sanitation.

A recent clearance of cow houses in Edinburgh, *Littlejohn*, 1463-7.

See also Milk and Dairies.

SMITH, Mr. J. B., Leeds, Treasurer of the National Confederation of Meat Traders' and Butchers' Association, and representative of Leeds Local Association. Analysis of Evidence of. *See* Myers.

SPORES, TUBERCULAR. *See* BACILLI and INHALATION.

SPUTUM:

Means of dealing with phthisical sputum in hospitals, *Ransome*, 1265, 1310*a*.

Experiments with sputum in a well-lighted and ventilated place gave negative, and in a badly-lighted and ventilated place, positive results, *Ransome*, 1334-40.

Danger of expectoration as a medium for conveying disease, *Littlejohn*, 1483-5.

SQUIRE, Dr. J. EDWARD, M.D., London, M.R.C.P., Physician to the North London Hospital for Consumption. Analysis of Evidence of.

Previous experience and appointments, 915-25.

The entrance of the bacillus is a necessary factor in the causation of the disease, which is communicable from individual to individual and species to species, 926-8, 954, 955.

Tuberculosis in man and animals is identical, and is communicated by the entrance of the germ, by inhalation, or ingestion, 929-34.

Experiments to show this were made long before the discovery of the bacillus, 964-8, 971-3.

SQUIRE, Dr. J. EDWARD—*continued.*

Hereditary Tuberculosis.

An inherited predisposition is an inherited weakness, which makes the individual more liable to succumb to the attack of the bacillus once admitted; but the inherited disease is possible, 935–8.

Persons born of tubercular parents would be more liable to infection, but would not necessarily become themselves tubercular, 939–41.

Tuberculous Food.

It is difficult to cite cases of the disease being contracted through food, as inhalation may have operated in producing infection, 942–5.

If a child is reared on its mother's milk, the mother being tuberculous, there is a risk of infection; children fed by hand may contract the disease through tubercular milk; the tubercle forms in the intestines and mesenteric glands, and then general tuberculosis sets in; in the case of infection from inhalation the lungs would be first affected, 946–50, 956.

The children of the poor would be more liable to attack than those of the rich; feeding on unnatural food would predispose to consumption of the bowels, 951–3.

Children consume more milk than meat, and adults *vice versâ;* children being more liable to tuberculosis points to the greater danger from milk than meat, 995–1001.

There is more danger from milk than meat, and from both the danger would not always be eradicated by cooking, 960–3.

A person in good health would resist the attack of the germs in the air or in the food he eats, 958–9.

Although the amount of consumption in animals has increased, it has decreased in man; this shows that the risk from inhalation is greater than that from tuberculous meat and milk, so that even were the supply of tuberculous food cut off there would still be the danger of contracting the disease, 969–70, 984, 986–90.

Tuberculosis in Animals.

The disease has not been found in wild animals, 974.

If sheep, rarely tuberculous, were confined in stables as cattle are, it is likely they would be found equally tuberculous, 975–82.

The herbivora suffer in larger proportion than the carnivora, from which it is deduced that the disease is more liable to infect animals through inhalation than ingestion, and that would also apply to man, 983–4.

Conditions of Life with respect to Consumption.

The decrease of consumption in the last quarter of a century is due to improved hygienic conditions of life, 985.

Special conditions of life, working at a business which compels the inhalation of a large amount of dust, or being exposed to infection after an illness, would increase susceptibility, 957.

It would be more desirable and practicable to make regulations for better hygienic conditions and housing of cattle, than to make food regulations, 991–4.

SUSCEPTIBILITY TO CONTRACT TUBERCULOSIS:

There are two kinds of predisposition to contract the disease, one of the species, and the other of the individuals of the same species, *Klein,* 798–809.

The susceptibility in man and animals is the same, *Klein,* 833.

Man.

The children of the poor, who are constitutionally, or, perhaps, temporarily weak, would easily contract the disease from tuberculous milk, *Woodhead,* 239–59; 465–72.

Comparative liability of the inhabitants of Demerara to contract the disease, *Williams,* 727–32.

Hereditary susceptibility or predisposition to tuberculosis. *See* Hereditary Tuberculosis.

SUSCEPTIBILITY TO CONTRACT TUBERCULOSIS—*continued.*

Animals.

Animals in the open air are likely to be more free from the disease, *Squire,* 974–83; *Littlejohn,* 1507–8, 1513–21.

Poultry are susceptible to tuberculosis, cats and dogs are not, *Dreschfeld,* 131–2, 148–9; *see also Klein,* 753–90.

Poultry and rabbits are much more susceptible than cattle and sheep, *Watson,* 1780–2. *See also* Animals, *Susceptibility,* &c.

TABES MESENTERICA:

Is a form of tuberculosis arising from ingestion of tubercular matter, *Klein,* 557–61. *See also* Children, Diseases of.

TUBERCULOSIS:

Definition.

The diseases commonly understood under the head of consumption of the lungs, besides tuberculosis, are those resulting from pneumonia, croupous pneumonia, gangrene, cirrhosis, septic processes in the lungs, and the group of diseases known as bronchial pneumonia, *Klein,* 744–5.

No disease should be called tuberculosis unless the bacilli can, by experiments or otherwise, be demonstrated, *Klein,* 752.

Symptoms and signs which would point out the existence of tuberculosis, *Klein,* 629–30.

The disease in man and animals is identical, but in the latter is more virulent, *Horsley,* 1630; *Woodhead,* 219–30; *Klein,* 543–49, 574; *Goodhart,* 1362–3; *Squire,* 926–34; *Powell,* 1125–30.

The geographical distribution of tuberculosis, *Ransome,* 1344–7; *Horsley,* 1602.

Amongst the Negroes and East Indians. *See* Demerara.

The indications of tuberculosis, and what diseases are accompanied by tuberculosis, *Goodhart,* 1384–94, 1414–8.

Tuberculosis following other diseases, *Goodhart,* 1389–93.

Tuberculosis must be produced by the introduction, in one or another way, of the particular bacilli which produce the infection, *Klein,* 591–4; *Squire,* 926–29, *Barlow,* 1014–20.

The disease in a rapid and extensive form is much more virulent than where the progress is slower or the disease localised, *Klein,* 660–3.

The lung being the most favourable organ for developing the disease, pulmonary tuberculosis is more common than that caused by ingestion, *Klein,* 834–7.

Intestinal tuberculosis, *Goodhart,* 1382–4. Relation of tuberculosis of the mucous membrane of the lungs to that of the mediastinal glands, *Goodhart,* 1385–8.

Hospital statistics would in a broad way show the predominance of the disease in one group of organs or other, *Barlow,* 1111–3.

The probable place of entry of tuberculous matter into the body, and the conditions under which it enters, *Goodhart,* 1375–79; *Horsley,* 1603–6.

Tuberculosis produced experimentally. *See* "Experiments."

Tuberculosis produced by ingestion. *See* Food, Tuberculous, Meat and Milk. By Inhalation. *See* Inhalation.

See also Children, Diseases of; Methods of Contracting Tuberculosis; Susceptibility to Contract Tuberculosis; and Animals, Tuberculosis in.

VETERINARY SURGEON:

The inspection of meat by veterinary surgeons is preferable to the inspection by ordinary market inspectors, *Dreschfeld,* 67–73.

WATSON, Mr. EDWARD, President of the Glasgow United Fleshers' Society, Member of the County Council for Lanarkshire, and partner in the firm of Robertson and Johnston, cattle salesmen, Glasgow. Analysis of Evidence of.

Experience, 1699–1707.

The medical and sanitary authorities have exceeded their duties in that they have condemned meat

WATSON, Mr. EDWARD—*continued.*

which has never been proved to be dangerous to man; the flesh of animals that is self-evidently diseased should be condemned, but the healthy meat from an animal, parts of which were tuberculous and had been eradicated, should not be condemned; inspection would be best carried out at the slaughter-house, 1708–25.

The inspectors confine their operations to the slaughter-houses and public markets, and have every opportunity of examining the animals when disembowelled, 1726–33. The meat should be examined before it is permitted to go into the shops, but any meat, if well nourished and containing no evident disease, ought not to be condemned, 1734–9.

The original functions of the inspectors, under the Public Health Act, were to put aside putrid and overkept meat and diseased meat is included under these headings, 1740–8.

The increased vigour of inspection has brought about a loss to the meat trade in Glasgow, but it has kept out a great quantity of inferior cattle; they are slaughtered outside, and the dead meat is sent in with all traces of disease excised, 1750-69. The butchers have petitioned the local authority to provide a rigorous inspection, but they refuse to do so, since they might be held to guarantee the soundness of all the animals in the market, 1770; and the home supply has been supplanted, to a degree, by imported cattle, and imported dead meat, which cannot be so easily examined, 1771–80, 1789–93, 1802–7.

The imported live animals are inspected, as other live animals coming into Glasgow, 1834–8.

The same regulations should apply to rabbits and poultry, which are much more susceptible to the disease than are cattle and sheep, 1780–2.

There should be some compensation for animals, to all appearances well nourished and sound, which are by examination declared to be diseased and condemned, 1783–8.

From the appearance of the flesh it would be quite possible to say that an animal had been badly infected with tuberculosis, foot-and-mouth disease, or pneumonia, 1794–801.

Great mischief may be done by hasty and superficial examination, 1808–10.

If meat was good meat, though from a tuberculous animal, it should not be condemned, 1811–21, 1829–33.

The inspectors should gain their knowledge of what is, or is not, good meat by experience; those in Glasgow are excellent judges, 1823–8.

WILLIAMS, Dr. A. DAWSON, M.B., diploma of Public Health, Cambridge, Surgeon in charge of the Public Hospital, George Town, Demerara. Analysis of Evidence of.

Part experience in the Colonial service, 673–4.

"Consumption" is very common in British Guiana, amongst the negroes and coolies; there are few whites in the colony, two-thirds of the population are negroes and persons of mixed blood, the remainder being East Indians, 675–80.

There is more consumption than there was 50 years ago; the negroes suffer more than the Hindoos, 681–3.

About 1,000 deaths occur annually in the hospital, of which 25 per cent. are from phthisis and acute tuberculosis, 685–6.

The inhabitants eat very little meat, their tuberculosis is mainly contracted through inhalation of the products of previously existing cases, the predisposition being increased by the close atmosphere, 687–95, 720.

The disease cannot be contracted from eating (tuberculous) meat, as what little is used is well salted and cooked, 696–702, 721–6.

It is the general opinion that consumption has increased in the colony, 696–9, 703–7.

The disease more affects the younger people amongst the negroes; they do not consume a great amount of milk, 709–16.

The coolies use more milk than the negroes; the milk is usually boiled, 740–3.

The negroes are subject to the more acute and rapid form of tuberculosis, whereas the coolies suffer from the disease in the form usually seen in England, 717–9.

WATSON, Mr. EDWARD—*continued.*

The Hindoos and negroes live under much the same circumstances, the former are more associated with the cattle, yet they do not suffer with such intensity, 729–34.

In the post-mortem examinations the lungs seem to be the organs most affected, 736–9. Statistics of the disease in the colony. *Printed at the end of witness's evidence.*

WOODHEAD, Dr. GERMAN SIMS, F.R.C.P., Edinburgh, F.R.S.E., Director of the Laboratories of the conjoint Examining Board in England, of the Royal Colleges of Physicians and Surgeons. Analysis of Evidence of.

Past and present appointments, &c., 212–17.

There is no distinction between human and bovine tuberculosis, but there is no evidence of transmission, 220–30.

Milk, Tuberculosis conveyed by.

An examination of a number of cases of children suffering from tabes mesenterica, has shown the origin of the disease to have been in the alimentary tract or glands, 231–4.

Comparative extent of tabes mesenterica in children, 376.

In conjunction with Professor McFadyean, witness examined a number of cows in Edinburgh, and demonstrated the existence of tubercle bacilli in the milk of a proportion of them (Professor Bang demonstrated a similar fact at the International Congress in Copenhagen), 235–7.

Infection from tuberculous milk is only to be apprehended in the case of children predisposed to the disease, temporarily or permanently, this would especially include the children of the poor; and there is no doubt that tuberculous milk is a great cause of infantile disease and mortality, 239–59, 465–72.

The length of life of the bacilli in dairy products, 379, 380.

The risk from milk is universal, 410*a*–14.

Meat, Tuberculosis conveyed by.

There is a wide difference between experimentally producing the disease through inoculation and the assumption that tuberculosis is to be contracted by using the flesh as food; when cooked the flesh at the centre of the joint would not always be sterilised, but as a rule the cooking would render the meat harmless, 260–5.

The use of milk is constant, as compared to that of meat; a patient might eat a sufficiently large quantity of tuberculous meat at one meal to induce tuberculosis, and thus with meat, as with milk, the digestive organs can be made the medium to convey infection, 266–70.

Copenhagen, Meat Inspection in.

The regulations were instituted in Copenhagen by a local Act of Parliament in consequence of the prevalence of tuberculosis in Denmark, 296–301.

The meat is placed in two classes, (1) that killed in Copenhagen, and (2) that killed without and brought into Copenhagen.

With regard to that killed in Copenhagen, a most searching examination of the carcases is made by the inspectors; if general tuberculosis is discovered the whole carcase is destroyed; it may be boiled down to be used in the manufactory of soap, but it is not permitted to reach the food supply; if it is only partly tuberculous, and there is no evidence of rapid spread of the disease, they pass the unaffected portions, 271–9.

The inspectors wish for an extension of their powers. Their proceedings are controlled by an Act of Parliament, and they are willingly submitted to by the population, 280–5, 328–34.

In 1885 15 slaughtering cells were instituted, which might be hired by butchers. If the cells were used, the meat was inspected and stamped. They were sought after by the butchers, who started a mutual insurance system, 286–93.

The authorities say the advantages derived from the system cannot be overstated, 294–5.

There is at Copenhagen a general slaughterhouse for the meat killed within, and at the railway station a central office where is examined all the meat

WOODHEAD, Dr. GERMAN SIMS—*continued.*

killed outside Copenhagen, 308. All the meat is examined and marked, the stamps being of four classes: 1st class. For meat from Animals slaughtered in public abattoirs, and all parts being sound; 2nd class. Animals slaughtered without the city, all parts being sound; 3rd class. Animals slaughtered at the public abattoirs, parts of which were affected and destroyed; 4th class. Animals slaughtered outside, parts of which were affected and destroyed, 310–13.

The second class meat (3 and 4) is not sought after by the consumers, 335–6.

The cooking in Copenhagen is more thorough, 377–8a.

The prices for (*a*) the inspection at the railway stations, and for (*b*) the use of a well-equipped public abattoir and inspection, are the same. The system pays its own expenses, 313–8.

Proposals as to the adoption of Inspection in Great Britain.

The system might be carried out in Great Britain. All meat should be inspected and marked, 303–306, 309.

In this country should be established a prohibition against the use of meat from oxen, cows, and swine, unless it is sold under a system of public inspection, and certified, 314, 315. There might be a system of mutual insurance among the farmers, &c., with contributions from the rates and taxes, 316, 317.

Such precautions with regard to meat and milk would in time cause a considerable decrease in the amount of disease, but would not eradicate it, 360–3, 395–7.

All tuberculous animals should be slaughtered, and all animals inspected, 405–10.

There must be maintained as large and skilful staffs of veterinary inspectors as in Copenhagen, 415–29, 487–91.

The inspection of slaughterhouses and imported meat in this country would be no small matter, 478–86, 494–510.

Such a system would be welcomed by the meat trade, 512–13.

WOODHEAD, Dr. GERMAN SIMS—*continued.*

Theoretically the disease might be stamped out, 528–35.

The owners of the cattle insure themselves against loss by paying at the abattoir a premium, varied according to the animals slaughtered, 318–24.

The percentage of calves condemned is small, as is that of sheep. About 17 per cent. of all the meat brought in is found to be infected, 324–8, 346–50. *See also* statistical tables at end of evidence.

Methods of contracting Tuberculosis.

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A predisposition to contract the disease may be inherited or acquired, but the disease must be acquired *ab extra.* Congenital tuberculosis is very rare, 430–56.

The disease is established by inhaling or ingesting the specific poison, 356–9.

In a phthisical patient tubercle-bacilli would be expected to be found in the mucus of the throat and the larynx sooner than in the intestines. They are the actual existing cause of the disease, 364–71.

The rapidity of the spread of disease in animals depends on their constitution and age, the older and weaker the more susceptible they are, 372–5.

Milk Inspection in Copenhagen.

There is a voluntary association which does an immense business in the city. All the milk sent in by the farmers is perfectly inspected, the tuberculous milk is destroyed, and the owners are compensated whilst there is any doubt, 381–94.

Has produced tuberculosis by inoculating animals, with the apparently healthy organs of an animal dying from tuberculosis, 399–404.

Feeding experiments have caused calves to contract tuberculosis in three months, 457–64.

Suggests a method of diagnosis of disease in the living animal, 536–7. Statistics of tuberculosis (human and comparative) in Copenhagen, 1888–94, printed at end of evidence.

Part III.

APPENDIX. SPECIAL INQUIRIES.

ROYAL COMMISSION ON TUBERCULOSIS.

Part III.

APPENDIX.

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DIGEST OF INQUIRY I.

Report by Professor McFadyean on Experiments undertaken by him at the instance of the Royal Commission.

Object:—To seek the Means of recognising Tuberculosis in Animals during Life.

N.B.—*The numbers in brackets are references to the paragraph numbers in the full print of the Report.*

PART I.

The Detection of Tubercle Bacilli during Life.

The detection during life is restricted, because, (1) tubercle bacilli are generally confined to the actual lesions, and (2) in many cases the primary lesions are situated in parts of the body that are not accessible to examination. (1–2.)

The Blood.

It was generally believed that tuberculosis in cattle affected the whole body, and that thus the bacilli should be detected in the blood. Blood was drawn from living tuberculous cows; rabbits inoculated with it on being killed—in about 40 days' time—were found to be unaffected. From these and other experiments it is concluded that in cases of tuberculosis an examination of the blood could only, by a happy accident, warrant a positive diagnosis or prove that an animal was free from tuberculosis; it is clear then that, even when greater numbers of bacilli collect in the blood at the early stages of the disease, they gradually filter through to the lungs and other organs. (3–8.)

Milk.

By examination of the milk microscopically, a positive diagnosis may be made only in the case of tuberculosis in the udder; and thus this milk examination cannot be regarded as a trustworthy means of diagnosis. From inoculation experiments, it is assumed that the bacilli are not contained in milk from tuberculous cows, unless the udders are tuberculous. (9–19.)

Expectorate.

The value of examination of the sputum in the diagnosis of a pulmonary consumptive human subject suggested the similar diagnosis of animal tuberculosis. Mucus was collected from cows—which by post-mortem examination proved to have tuberculous lesions in the lungs—and this was microscopically examined, but three out of the four cases failed to show any signs of tubercle bacilli. This mode of making a diagnosis cannot be regarded as trustworthy.

Inoculation experiments have given positive results, but for practical purposes they are too slow. (29–30.)

Other Secretions.

Tuberculous lesions in certain organs might be discovered by microscopically examining the discharges, but these cases are proportionally few, so that the examination of genito-urinary discharge is of little practical use. (31.)

Exploratory puncture.

In mammary tuberculosis an examination of the milk usually reveals tubercle bacilli, but cases of mastitis are met with where scarcely a drop of secretion is obtainable. In these cases exploratory puncture will demonstrate tubercle bacilli in greater numbers than would be discovered by milk examination; this method, though valuable and harmless, might be objected to by owners. (32, 33.)

PART II.

Diagnosis of Tuberculosis by ordinary Clinical Methods.

A certain clinical diagnosis can seldom be made, but in the common pulmonary form of the disease the history, emaciation, the symptoms pointing to the disease and evidence yielded by percussion or auscultation, generally clearly demonstrate the disease; in default of these symptoms the clinical methods that could be resorted to are— (34–8.)

Temperature.

Thermometric observations are of no value, as the temperature of tuberculous animals generally remains normal. (39.)

Physical Examination of the Chest.

This is also of little use for the detection of lesions not translated by actual symptoms. (40.)

Physical Examination of the Abdomen.

A rectal exploration is the only means; this is of little value. (41.)

Examination of the Superficial Groups of Lymphatic Glands.

Glandular enlargement, which is suspicious, together with an exploratory puncture might warrant a positive diagnosis; but the absence of such enlargement does not warrant the conclusion that the disease is absent. (42–7.)

PART III.

Diagnosis by means of Injecting Tuberculin.

By experimentally inoculating a number of cattle with tuberculin, the rise or the stationary condition of temperature is held to indicate respectively the presence or absence of the disease; by post-mortem examination this indication was shown to be correct in 51 cases and wrong in 24.

Tables are given showing the rise in temperature in animals injected with tuberculin at various periods.

In the majority of cases it would be possible to detect tuberculosis in its early stages by means of injecting tuberculin; by a double inoculation, with an interval between the injections, it is probable that the proportion of errors will be very small. (48–72.)

DIGEST OF INQUIRY II.

REPORT of EXPERIMENTS undertaken by SIDNEY MARTIN, M.D., B.S., B.Sc., F.R.C.P., Assistant Physician to University College Hospital, and to the Hospital for Consumption and Diseases of the Chest, Brompton.

Object:—As to FOOD of TUBERCULAR ORIGIN; its infectivity to lower animals.

N.B.—*The numbers in brackets are references to the paragraph numbers in the full print of the Report.*

GENERAL SUMMARY OF RESULTS (i–v.).

PART 1.

Generally describes the places where the experiments were carried out, and the strict hygienic precautions taken with respect to the housing and feeding arrangements of the animals, so as to preclude as much as possible the contraction of the disease *ab extra*. (1–5.)

The animals used in the investigation were guinea-pigs, rabbits, pigs, and calves; the two former being highly susceptible, and the two latter to a less degree susceptible to tuberculosis. To decide whether these animals were tuberculous or not, before being experimented upon, post-mortem examinations were made upon non-experimental animals kept as controls. (6.)

Table I., shows the cause of death of all the guinea-pigs experimented upon.

Rabbits and Guinea-pigs.

The experiments of inoculating and feeding them with tuberculous meat and milk show that, if kept under ordinary hygienic conditions, they may be used as a very delicate test for the infectivity of tuberculous material. (11–12.)

Pigs.

Are not, from the results of the experiments, such satisfactory animals as rodents to use for experiments with tuberculosis. (13–17.)

Table II. shows litters of pigs used, experiments, and results.

Calves.

The only possible precaution was to keep these some time before use.

The COURSE of TUBERCULOSIS in ANIMALS.

In the case of—

1. Subcutaneous inoculation of tuberculous material in guinea-pigs and rabbits. *See also* Table III. (21–5.)

2. Intra-peritoneal injection of tuberculous material. *See also* Table IV. (26–7.)

3. Feeding of rodents, pigs, and calves with tuberculous material. (28.)
   - (*a*.) Tuberculosis in guinea-pigs, following single feeding with phthisical sputum. *See also* Table V. (28–9.)
   - (*b*.) Tuberculosis in guinea-pigs following a single feeding with bovine tuberculous material. *See also* Table VI. (30–33.)
   - (*c*.) Rabbits. (34.)

4. Feeding pigs with meat and milk. *See also* Table VIII. (35–40.)

5. (*a*). Feeding calves with bovine tubercular material (41–5.)
   (*b*.) Feeding calves with human tubercular material. *See also* Table IX. (42–5.)

The Pathological Diagnosis of Tuberculosis, and of other forms of Bacterial Necrosis.

The appearances of tubercular lesions to the naked eye. (46.)

Diagnosis through the course of the disease. (47.)

Diagnosis by means of microscopical examination. (48–52.)

Cases of bacterial necrosis in experimental and non-experimental guinea-pigs. (Table X.) (53–4.)

PART II.

REPORT on the EXPERIMENTS with the MEAT of TUBERCULOUS COWS.

Object.

To test whether the meat of tuberculous cows was capable of giving the disease to animals fed or inoculated with it (55).

Method of Procedure.

Describes the carcases used, the treatment of the meat, the precautions taken, and amount of meat and meat juice given the animals experimented upon, either by inoculation or as food. The meat used was examined, and the degree of tuberculosis in it ascertained (56–78).

Results of Experiments.

Experiments were made upon rabbits and guinea-pigs by feeding and inoculation respectively with the meat and meat juice of cows suffering from *mild* tuberculosis (result + 1 — 61), (Table XVI.), (79–80); with the meat and meat juice of cows suffering from *moderate* tuberculosis (result + 4 — 51), (Table XVII.), (83); with the meat and meat juice of cows in an *advanced and generalised* state of tuberculosis (result + 11 — 23), (Table XVIII.), (84); of the animals fed, six developed tuberculosis, and of those inoculated, 10 developed the disease (Table XIX.), (85.) Comments upon the irregular results of these experiments (Tables XX.–XXII.), (86–92.) The degree of tuberculosis produced in an experimental animal depends upon (1) the state of activity of the infective agent, (2) the quantity of the infective agent introduced, (3) the degree of susceptibility of the animal to the disease (93–100).

Conclusions.

The positive results cannot be attributed to the presence of bacilli in the blood, they possibly may have been due to the presence of bacilli in the muscle, but most probably should be attributed to the accidental contamination of the meat in trimming (101–12); from this conclusions are drawn as to the degree and locality of tuberculosis in animals, such as would qualify their meat to be passed or condemned (113–123).

PART III.

REPORTS on EXPERIMENTS with the MILK of TUBERCULOUS COWS.

Object.

To test whether the milk of tuberculous cows was capable of giving the disease by feeding or inoculating animals with it (124).

Explains the method of procedure (125–7).

Results of the experiments (128–55).

Conclusions.

The milk of tuberculous cows should be divided into two classes: (1) that given by cows the subject of tuberculosis of the internal organs without tuberculous disease of the udder; (2) that given by cows the subject of tuberculosis of the internal organs and of the udder; the first condition is not associated with infectivity of the milk, but the second is, therefore cows in the second condition should be slaughtered (156–7).

The Diagnosis of Tuberculosis of the Udder of the Cow.

The diagnosis, from a history of the disease, and from a physical examination, is uncertain (158–9). The diagnosis by the irregular supply of milk, and by the chemical and physical characteristics of the milk is worthless; in the early stages of the disease it is not always possible to discover tubercle-bacilli in the milk, the only successful means is by experimental inoculation (160–5).

Precautions to be taken.

Milk as an article of diet or as any milk product should not be permitted to be used when its origin is from cows in which one or more of the quarters of the udder is enlarged or nodular, or where the supply from one or more quarters fails in quantity or quality; all cows with advanced tuberculosis should be excluded from the dairy (166).

PART IV.

Report on the Results of the Injection of Koch's Tuberculin in Cattle.

Two tuberculous calves and two non-tuberculous calves were injected with tuberculin, and the temperature of the two former showed a marked rise as compared to that of the two latter (167–9); similar results were obtained with cows, this would thus afford some service in the diagnosis of the disease (169–72); details of above (173–84).

PART V.

Details of the Post-Mortem Examination of the Cows whose Meat and Milk were used for Experiments.

PART VI.

History, Temperature, &c. of the Milch Cows used in the Investigation.

PART VII.

Details of the Experiments made with the Meat of Tuberculous Cows.

PART VIII.

Details of the Experiments made with the Milk of Tuberculous Cows.

PART IX.

Details of the Feeding Experiments made with Human and Bovine Material.

DIGEST OF INQUIRY III.

Report by German Sims Woodhead, M.D., Director of the Laboratories of the Royal Colleges of Physicians (London), and Surgeons (England), upon Experiments made by him with the help of several other gentlemen, on behalf of the Royal Commission.

Object:—To determine how far Cooking Processes destroy the Infectivity of Tubercle.

N.B.—The numbers in brackets are references to the paragraph numbers in the full print of the Report.

Part I.

Generally describes the accommodation for the animals experimented upon; and the strict precautionary disinfectant methods taken to lessen the possibility of infection outside the experiments, by means of washing and tarring the sheds, etc., sterilizing feeding troughs; and the shed used for photographic and laboratory work, some of the latter being carried on at the laboratories of the Royal College of Physicians (London) and Surgeons (England) (1–8).

General Method of Enquiry.

After preliminary experiments, it was decided to use guinea-pigs (herbivora), cats (carnivora), and pigs (omnivora); all are susceptible to tuberculosis, though they will not contract it unless brought directly under the influence of the infective material, and all can be kept in limited quarters and obtained in families, thus being as like as possible in constitution and hereditary character; none of the control animals contracted tuberculosis.

The mortality amongst the control animals, small as it was, was due to change of diet, pneumonia, and intensely cold weather.

The tuberculous material used was from pigs, cattle and human phthisical beings (9–15).

Part II.

Report on Feeding and Inoculating Experiments with Raw or Plunged Meat, taken from Cows with mild, moderate, or advanced Tuberculosis, in order to control the value of the experiments made with the same meat cooked (*see* Part III.).

General Method of Procedure.

The meat used was taken from several parts of the carcase all more or less affected with the disease.

Nineteen carcases were so carefully obtained and in such good condition that they could be fairly used for experimental purposes, but others were contaminated during their transport, and were thus unfit (17–21).

Method of taking and preparing the Experimental Meat.

The carcases were dressed most carefully in the ordinary way by the butcher and the joints used cut in as solid blocks as possible so that the centre of the meat should be far from the exterior. All possible disinfectant precautions were taken in the transport and preservation of the meat; the meat used was raw or plunged in boiling water to obviate contamination. The quantity given in experiments varied considerably, there were also inoculating experiments, the results of all being set forth in tables (Tables I.–IV.). They show the results of using raw and plunged meat (corresponding to the trimmed and untrimmed meat of Inquiry II.) and should be compared with tables in Inquiry II. (22–29.)

Condition of the Cows used.

Some of the meat was taken from cows so tuberculous as to be unfit for human consumption, but much of the flesh appeared healthy to the eye. In many of the cases there were caseous and fibroid patches in the muscle, which together with hyaline patches were especially noticeable under microscopical examination.

The positive results produced may have been due to the presence of bacilli in the inter-muscular spaces or to accidental contamination (29–32).

The use of Tuberculin.

In the cases in which muscular tuberculosis was found, tuberculin had been injected two days previous to slaughter; the most marked consequence of the injection is the formation of fibrous tissue (33–5).

The action of the Bacillus Tuberculosis.

The number of bacilli introduced, the point at which they are introduced, and the susceptibility of the subject, determine the degree of tuberculosis; another important factor is whether the products of the micro-organisms are introduced as well as the micro-organisms themselves, the varied quantity introduced might explain the irregular results of experiments (36–7).

Plunging Experiments.

The plunging of contaminated meat into boiling water materially lessens the infectivity (38–40).

Possible modes of Infection.

The butcher's knife, hands, and cloth used to wipe the carcase may easily convey infection; meat given to children in a raw state should be plunged to obviate the danger; again, rolled meat is a source of danger (41–2).

Degrees of Susceptibility of different Animals.

Cats are very much more resistant than pigs or guinea-pigs, but when they do contract the disease the tubercle bacilli are very numerous in the lesions; whereas pigs and guinea-pigs will succumb to a comparatively few; the older the cat the more is its resisting power. The outcome of this is that where tubercle bacilli are few, there is often least tissue resistance by the recipient and vice versâ (44–5).

Number and Virulence of Tubercle Bacilli.

The differences in results are more due to the change in the number of bacilli than to the change in the virulence. There is marked evidence of the attenuating influence of heat on the bacilli (46).

Differences in Susceptibility of Animals to Attack at Different Points.

There is marked difference of susceptibility in species and individuals of species, dependent on age, constitution, history, &c. Tubercular material heated so as to be innocuous to guinea pigs, is virulent to pigs; they are both equally susceptible to unheated material; perhaps the divergence is due to the different points at which the animals are attacked.

There is a similarity between tubercle in pigs and scrofula in children (47–9).

General Conclusions.

By carefully isolating tuberculous meat contamination is easily avoided, especially in the case of mild tuberculosis; but meat from generally tuberculous animals is very rarely free from the contamination due to smearing. There is great danger from this meat, and also from healthy meat dressed by the same person and implements by whom and which tuberculous meat has been dressed; great care must be exercised by inspectors with regard to contaminated meat; no organs from an affected cavity should be used for food, and no tubercular animals into which tuberculin has been injected should so be used; carcases in which tuberculosis is advanced, and parts and organs near tubercular lesions should be condemned, and the inspectors, when in doubt, should condemn (50–61).

Practical Recommendations.

Every animal should be inspected ante mortem by a veterinary surgeon in conjunction with the medical officer of health. There should be separate abattoirs for suspected tuberculous cows; slaughter houses should be licensed and the workers specially educated; in the case of tuberculous animals there should be inspection before and during dressing, which must be carried out with sterilized knives, and all parts and organs must be examined. If the condemned portions are required for extraction of fat or gelatine or as manure they must be thoroughly sterilized, if not they must be entirely destroyed.

The healthy portions, passed by the inspectors of condemned carcases, should be plunged to absolutely sterilize the meat (62–3).

PART III.

Report on Feeding and Inoculating Experiments with Meat from Tuberculous Cows, the Meat being (*a*) Boiled and (*b*) Roasted as for use at Table, in order to test whether the Infectivity was Destroyed by the Cooking.

The experiments in Part II., made with the same meat uncooked, act as controls; the cooking was carried out as in an ordinary kitchen (64).

(*a.*) Boiling.

The meat was kept in water, in a tin vessel, at boiling point, giving a quarter of an hour's boiling to each pound of meat.

Results.

Of 56 guinea-pigs fed with boiled meat, none developed tuberculosis, whilst of 55 fed with the same meat raw one developed the disease.

Of three inoculated with the boiled meat, all were unaffected; of 21 inoculated with the same meat raw, five developed tuberculosis (65–7 and 69).

(*b.*) Roasting.

The meat was roasted for 20 minutes per pound (68).

Results.

Of 48 animals fed with roast meat none were affected, while 60 fed with the same meat raw, three became tuberculous; seven animals inoculated with the roast meat were unaffected, whilst of 22 inoculated with the same meat raw, four became tuberculous. Tables VI., VII., and VIII. clearly show the full results of these experiments.

PART IV.

Report on Feeding and Inoculation Experiments (with Controls) with Manifestly Tuberculous Materials—Glands, Lung, Udder, &c.—to determine its Infectivity when (*a*) Boiled and (*b*) Roasted (72).

The material used was easily demonstrated to contain tubercle bacilli (73).

(*a.*) Boiling.

Of 41 animals fed with this obviously tubercular material boiled, four developed tuberculosis, whilst of 18 fed on the same material raw, 14 developed tuberculosis; lung was not easily disinfected. Two out of 16 animals inoculated with the boiled material became tuberculous, whilst 11 out of 12 inoculated with the raw meat were positive (74).

(*b.*) Roasting.

Three out of five animals fed with the roast material, and two out of three fed with the material raw, gave positive results. One animal inoculated with the roast material was unaffected (75).

Conclusions.

The more tuberculous the material, the more positive will be the results; the most deadly tuberculous material can be rendered innocuous by the action of a temperature at which the water boils.

Tables IX., X., and XI. illustrate these experiments (76–77).

PART V.

Report on Feeding and Inoculation Experiments (with Controls) with Meat rendered Infective by the addition of obviously Tubercular Material (*a*) Boiled and (*b*) Roasted.

Object.

It having been proved that tuberculous material, accidentally smeared on the outside of a joint, can be rendered innocuous by cooking, it was thought necessary to determine the infectivity of meat intentionally contaminated and then cooked (78).

Method of Procedure.

Meat was obtained from a butcher, the bone removed; it was then cut into strips, and smeared with a greater amount of tubercular material than would accidentally be introduced; it was rolled and tied very tight, and was boiled for 15 minutes per pound, and roasted for 20 minutes per pound. In two cases the infective material was introduced by a glass pipette 3½ inches from the centre of the meat. The meat being cooled, portions were pounded with water in a sterilized mortar, and this fluid was used for injection and inoculation. The meat being obviously tuberculous no control inoculations were needed (79).

(*a.*) Boiling.

Two animals out of 15 fed contracted the disease by ingesting the boiled material, and 8 of 9 with the raw material; 11 out of 18 inoculated with the boiled material became tuberculous (82).

(*b.*) Roasting.

Fed with the roast material 5 out of 21 became tuberculous; fed with the material raw 10 out of 11 became tuberculous, and 10 out of 20 inoculated with the roast material became tuberculous (83).

Conclusions.

It is evident that the ordinary methods of cooking do not destroy the infectivity of meat which has been rolled when contaminated with tubercular material.

If the peritoneal layer investing the thin muscle of the abdomen of the cow is affected the muscular wall should be confiscated and destroyed (85).

Tables XII.–XIV. illustrate these experiments.

PART VI.

Report on Temperature Experiments made with Fusible Metal placed in Meat that was afterwards Boiled or Roasted.

Object.

To determine whether it was possible to obtain a sufficiently high temperature by the ordinary methods of cooking to ensure destroying the infectivity from and at the centre to the surface of meat (86).

Methods of Procedure.

Fusible metal was placed in the meat and so tied that it should be protected from the action of the fire and water; in an ordinary joint accidental contamination would be at the surface; where the meat is rolled it might be at the centre or any other point of the mass. The experiments were carried out by (A.) boiling, (B.) roasting in gas ovens, in ovens heated by a coal fire, and before a coal fire (87).

(A.) Boiling.

The meat was introduced when the water was at boiling point.

The following general results were obtained:—The fusible metal, melting point 60° C., was melted 4 times out of 6, once not, and once rendered plastic.

Melting point 70° C.; melted 3 times out of 8, once partially, once rendered plastic, and 3 times not melted.

Melting point 80° C.; melted 5 times out of 8, twice not, and once partially.

Melting point 90° C.; of three cases, in none was the metal melted.

The full results obtained are set forth in Tables XV.–XVIII. (89).

(B.) Roasting.

The experiments were carried out in a gas oven at a comparatively low temperature, allowing 20 minutes per pound.

The following general results were obtained:—Melting point 60° C., melted 5 times out of 12, and 7 times did not melt.

Melting point 70° C.; melted 3 times only out of 15.

Melting point 80° C.; melted once only out of 6 times.

The full results are set forth in Tables XIX.–XXI. (91).

Conclusions.

The ordinary cooking methods in joints under 6 pounds would be sufficient to destroy infection, but in the case of joints or rolls above that weight a sufficiently high temperature would not be reached to annul the infection in the centre, though it might annul it at the surface. (94).

PART VII.

Report on Temperature Experiments with Thermometers placed in the Meat which was afterwards subjected to a Process of either Boiling or of Roasting.

Object.

To control the experiments of Part VI. (95).

(A.) Boiling.

Joints between 6 lbs. and 7 lbs. 13 ozs. were taken, an incision made, into which the thermometer was introduced; a quarter of an hour's boiling was given for each pound.

The following general results were obtained:—All cases reached a temperature of above 50° C., 7 above 60°, 4 above 70°, 2 reached 80°, and 1 only above 80°. After removal from the water the temperature continued to rise in 7 cases for 10 minutes, 6 for 15 minutes, 5 for 20 minutes, 5 for 25 minutes, 4 for 30 minutes, and 1 only for 40 minutes.

The detailed experiments are given in Table XXII. (96).

(B.) Roasting.

The experiments were carried out in gas ovens, coal ovens, and in front of the fire, the temperatures varying considerably; the maximum thermometric readings obtained during these experiments are given in Table XXIII.

This table shows that the results were according to the conditions of the experiments, amount of gas and fuel used, the highest reading was 280° C. In the gas oven the temperature was modified by the amount of gas burned; the experiments were carried out without basting; irregularities may be explained by the size of the joints or the leaking of hot fat on to the thermometer bulb (97–8).

Gas Oven Experiments.

The meat was cooked in the house more rapidly than in the stables, using the same gas pressure in both ovens.

The following general results were obtained:—In all cases a temperature of 40° C. was reached, 11 reached 50°, 9 reached 60°, 4 reached 70°, 3 reached 80°, 2 reached 90°, and 1 only reached 100°. After removal from the oven, in 6 cases the temperature continued to rise for 10 minutes, 5 for 15 minutes, and 2 for 30 minutes.

The full details are given in Table XXIV. (99).

Coal Oven Experiments.

These joints were served at table and considered well cooked.

The following general results were obtained:—All cases reached a temperature of 40° C., 7 reached 60°, 6 reached 70°, 4 reached 80°, and 3 reached 100°, and in each of 3 of these cases the temperature fell on removal from the oven.

The full details are given in Table XXV. (100).

Experiments in front of Coal Fire.

The temperature is much lower than when roasted in an oven, the joints were used at table and considered well cooked.

The following general results were obtained:—All cases reached a temperature of 50° C., 3 reached 60°, and 1 70°. After removal from the fire the temperature in 3 cases continued to rise for 10 minutes, 2 for 15 minutes, and 1 for 25 minutes.

For full details, *see* Table XXVI. (101).

Conclusions.

Ordinary cooking, such as boiling and roasting, though sufficient to sterilise the surface and the meat for a short distance from the surface, cannot be relied upon to annul the infectivity in small joints and rolls of meat at the centre, especially when they are over three or four pounds weight.

The least reliable method is roasting before the fire, then roasting in an oven, then boiling (102).

PART VIII.

Report on Feeding and Inoculation Experiments (Controlled by Experiments with Raw Milk) with Milk heated at various Temperatures, taken from Cows with Tubercular Udders.

Object.

To determine the conditions of temperature necessary to render innocuous to animals milk taken from cattle with distinctly tubercular udders, either by feeding or injection into one of the serous cavities, or into the subcutaneous tissues (103).

In these experiments pigs were found to be affected through the tonsils, as well as other parts of the alimentary tract. Control experiments were made in nearly all cases.

Experiments with Tubercular Milk.

Milk was used from four cows with tuberculous udders, and the milk of tuberculous cows with sound udders was useless, as the control experiments were negative.

In some cases the quantity of milk drawn from cows with tubercular udders is normal, but it is thin and watery and contains larger flocculi than normal milk, the flow of milk gradually decreases from the diseased quarter; as the yield diminishes the fluid becomes thicker, thenceforth it becomes possible to demonstrate microscopically the presence of bacilli, after this the milk becomes sero-purulent.

In one experimental cow (No. 21), the milk from two teats was quite normal, whilst the milk from the other two contained small flocculi and eventually tubercle bacilli. After death, three of the quarters of the udders were found to be tuberculous.

Thus, milk differing very slightly from normal milk might be distinctly infective.

Table XXVII. gives detailed experiments made upon guinea-pigs with the milk from each of the four teats of the afore-mentioned cow. The following general results were obtained:—6 of 12 guinea-pigs became tubercular, 5 did not, and the remaining one died too early to show tubercle. From these experiments it is shown that the period of the duration of the disease is regular when the same material is used, and that there may be only few bacilli in milk when no breaking down of the glandular tissue or the walls of the ducts is going on.

The onset of tuberculosis in the udder is very rapid, so much so that no tubercular animal should be allowed to remain on a dairy farm.

Tubercular udders are found in all stages of the disease in cattle, but a cow may be in an advanced stage of generalised tuberculosis, although there is not the slightest trace of disease in the udder, yet its milk should not be consumed, as the disease might at any time extend to the udder (104).

Method of Procedure in making the Experiments.

The milk was heated to any temperature in a specially designed sterilising apparatus (105). Special needles and syringe for inoculation and injection were used; both were sterilised after use. The milk that had been heated to the highest temperature was first used in order to avoid possible infection.

The milk was cooled to the body temperature before inoculation, and great care was taken in the feeding experiments to ensure sweetness of the feeding troughs (106–7).

Description of Experiments.

Cows that yielded tubercular milk were used in these experiments (108).

In the feeding experiments none of 11 guinea-pigs became tubercular; in the injection experiments 3 of 6 became tubercular.

The full results of feeding experiments with tubercular milk heated to 60° C. (140° F.), and inoculation experiments with the same, and their control experiments appear in Table XXVIII.

The full results of feeding and injection experiments with tubercular milk from another cow heated at 60° C. (140° F.), and their controls are given in Table XXIX. (109–12). The following general results were obtained:—In the feeding experiments none of 28 guinea-pigs became tubercular, and in the injection experiments none of 12.

Table XXX. shows similar experiments with milk heated at 65° C. (149° F.), (112). The following general results were obtained:—In the feeding experiments none of 24 guinea-pigs became tubercular, and in the injection experiments none of 21 guinea-pigs.

Tables XXXI., XXXII., and XXXIII. show the results of similar experiments with tubercular milk heated at 70° C. (158° F.), the milk being from two cows. The following general results were obtained:—In the first series, feeding experiments, none of 8 guinea-pigs became tubercular, and injection experiments, none of 8. In the second series, injection experiments, none of 11 guinea-pigs became tubercular. In the third series, none of 26 guinea-pigs became tubercular; injection experiments, none of 16 guinea-pigs became tubercular.

Table XXXIV. shows the results of experiments with tubercular milk placed *cold* in the steriliser when the water was heated to 70° C. (158° F.). The following general results were obtained:—Feeding experiments, 2 of 8 guinea-pigs, and 3 of 3 pigs became tubercular; injection experiments, 3 of 15 guinea-pigs became tubercular.

Table XXXV. gives full details of feeding experiments with tubercular milk heated at 75° C. (167° F.); none of 5 guinea-pigs became tubercular. Table XXXVI., milk at 80° C. (176° F.); none of 4 guinea-pigs became tubercular. Table XXXVII., milk at 85° C. (185° F.); none of 4 guinea-pigs became tubercular. Table XXXVIII., milk at 90° C. (194° F.), (121); none of 3 guinea-pigs became tubercular.

Remarks and Conclusions.

Irregular results were obtained, and these may be explained by the fact that the number of tubercle bacilli varies day by day, and in different samples, and that the quantity of milk from the affected teats varies. The longer the heating of the milk the greater would be the number of bacilli withdrawn from the fluid.

Milk from tubercular udders undoubtedly is infectious. Heated tubercular milk gradually loses its virulence as the temperature is raised, and time during which milk is exposed to it prolonged (120).

PART IX.

REPORT on FEEDING and INJECTION EXPERIMENTS (controlled by EXPERIMENTS with RAW MATERIAL) with MILK to which MANIFESTLY TUBERCULOUS MATERIAL had been added, HEATED at various TEMPERATURES.

Artificial tubercular milk had to be used, since the supply of naturally tubercular milk was too limited (122).

Method of Procedure.

Tubercular organs from condemned animals were thoroughly minced and ground time after time and added to sound milk which was strained to prevent lumps forming; by the same method human sputum was added to the milk (123).

Experiments.

Experiments (and results) with artificial tubercular milk heated to 50° C. (122° F.) are given in Table XLI. Feeding experiments, 11 of 34 guinea-pigs became tubercular, 1 of 3 kittens, but a cat was unaffected; injection experiments, 17 of 27 guinea-pigs, and 2 of 5 kittens became tubercular (124).

Table XLII. shows the results of experiments on guinea-pigs with artificial tubercular milk heated to 50° C. (122° F.); these show the progressive diminution in the virulence of the material heated, and the relative time required to render tubercular material innocuous in feeding and injection experiments (132).

Table XLV. shows the results of experiments with artificial tubercular milk heated at 55° C. (131° F.) Feeding experiments, 7 of 27 guinea-pigs became tubercular; injection experiments, 16 of 29 guinea-pigs became tubercular (135).

Tables XLVI. and XLVII. show results of experiments with artificial tubercular milk heated at 50° and 55° C. By these tables is shown the importance of every additional degree in the process of sterilisation (141).

Table XLIX. shows the results of feeding and inoculating experiments with artificial tubercular milk heated at 60° C. (140° F.). Feeding experiments, 2 of 38 guinea-pigs, 2 of 2 pigs, and none of 2 cats became tubercular; injection experiments, 27 of 71 guinea-pigs became tubercular (145).

Table LII. shows the results of feeding and inoculating experiments with tubercular milk heated at 65° C. (149° F.) Feeding experiments, 4 of 46 guinea-pigs, and 2 pigs became tubercular, but 4 kittens were unaffected; injection experiments, 25 of 100 guinea-pigs became tubercular (152).

Table LIV. shows the results of feeding and injection experiments with artificial tubercular milk at 60° and 65° C. (158).

Table LVI. shows the results of feeding and injection experiments with artificial tubercular milk heated at 70° C. (158° F.). Feeding experiments, 1 of 38 guinea-pigs became tubercular, 3 of 4 pigs became tubercular, but 2 kittens did not (161).

Table LVII. shows the results of feeding and injection experiments on guinea-pigs with artificial tubercular milk heated at 70° C. (158° F.) (165).

Table LIX. shows the results of feeding and injection experiments with artificial tubercular milk heated at 75° C. (167° F.). Feeding experiments, 1 of 9 guinea-pigs, 2 of 4 kittens, 3 of 3 pigs, and 1 cat became tubercular; injection experiments, 7 of 21 guinea-pigs became tubercular (169).

Table LX. shows the results of experiments on guinea-pigs with artificial tubercular milk heated at 75° C. (167° F.) (173).

Table LXI. shows results from feeding and injection experiments obtained with artificial tubercular milk heated at 70° and 75° C. (174).

Table LXIII. shows the results of feeding and injection experiments with artificial tubercular milk heated at 80° C. (176° F.). Feeding experiments, none of 11 guinea-pigs, neither of 2 cats, but 2 pigs became tubercular: injection experiments, 1 of 19 guinea-pigs became tubercular (176).

Table LXIV. shows the results of feeding and injection experiments on guinea-pigs with artificial tubercular milk heated at 80° C. (176° F.) (180).

Table LXVI. gives results of feeding and injection experiments with artificial tubercular milk heated at 85° C. (185° F.). Feeding experiments, none of 11 guinea-pigs became tubercular; and injection experiments, 3 of 14 became tubercular (182).

Table LXVII. gives the summary of results of feeding and injection experiments on guinea-pigs with artificial tubercular milk heated at 85° C. (185° F.) (183).

Table LXIX. gives the results of feeding and injection experiments with milk to which obviously, tubercular material had been added and heated to 90° C. (194° F.). Feeding experiments, none of 3 guinea-pigs became tubercular; injection experiments, all of 3 guinea-pigs became tubercular (184).

GENERAL RESULTS AND CONCLUSIONS.

Explanation of the variation in the results.

The results will naturally vary as the conditions of the experiments.

In the case of acute infective disease such as anthrax a single bacillus might, under certain conditions set up the disease, but as the bacillus is attenuated a larger dose is necessary to convey infection. It is very difficult to discover the amount of tubercle bacilli necessary to infect an animal, but by experiments it has been shown that 8 to 40 virulent bacilli inoculated into the peritoneal cavity will infect guinea-pigs.

The precise activity or standard of activity of tubercle bacilli has not been decided.

The concentration of a quantity of bacilli is an important factor of infection.

The longer any tubercular material is kept at a certain heat the less virulent becomes its power, and the course of the disease in the subject becomes prolonged.

With milk from tubercular udders parallel results are obtained, but with the artificial tubercular milk the results vary, because of the uneven distribution of the bacilli therein ; this is very difficult to avoid.

The mixture of phthisical sputum and milk is not so virulent as the mixture of milk and tubercular organs.

The presence of albuminous fluid in the mixture of milk and tubercular organs probably influences the results of experiments, and there is also scrum albumen in naturally tubercular milk which may account for unequal results obtained when the milk was heated ; raw milk gave regular results (187).

Feeding Experiments.

Animals have been infected with the disease by means of inoculating tubercular material that has failed in the ingestion experiments ; it is concluded that only a small proportion of the bacilli ingested are taken up by the alimentary tract.

It is important that there should be a fine state of division of tubercular material in feeding experiments, and with respect to this, the artificial mixture of phthisical sputum and milk is the mixture most resembling natural tubercular milk.

A larger number of tubercle bacilli are required to set up the disease when they are attenuated, and a shorter period of heating is required in feeding experiments than in inoculation experiments, to render the bacilli innocuous. The gastric juice may attenuate the power of the bacilli in the feeding experiments, but its influence may be eliminated by observing the points of the alimentary tract from which infection has taken place. The disease generally affects the tonsils in pigs, but not especially in guinea-pigs ; the large number of leucocytes and extraordinary development of the tonsils in the former readily take up the bacilli.

The results seem to show that guinea-pigs are not so well suited for experiments with weakened material as are pigs in order to obtain positive results (188).

Fallacies to be guarded against in studying Local Tuberculosis.

Local necrosis does not necessarily indicate infective power.

Local tuberculosis is no proof of the virus being still infective.

Attenuated bacilli cannot grow on artificial media (189).

Problems to be solved.

1. The relative virulence of milk from various tuberculous udders, and the conditions under which it might be rendered innocuous.

2. The conditions under which extremely virulent and concentrated artificial tubercular milk could be so modified by heat that it might be given with impunity, either by feeding or injection, to animals of varying degree of susceptibility to infection by tubercle (190).

Effect of diluting Milk.

Natural tubercular milk varies in virulence, but this may be caused by the dilution of the milk or the action of heat upon it.

[The experiments were carried on with the milk, and not with the sediment formed by centrifugalisation.]

All the samples of milk taken from tubercular udders were distinctly dangerous in a varying degree (191).

Precautions to be taken.

Milk should be scalded or heated to lessen the danger, or, what is more important, there should be inspection by a veterinary inspector before the milk reaches the dairy (192).

Method of heating.

Milk should be placed in a jug which should be placed in a pan containing the same amount of water (as there is milk), the milk should not be covered but constantly stirred, the water should be briskly heated (until the milk reaches 80° to 92° C) for about half an hour (193).

Inspection of Dairies and Dairy Farms.

The veterinary surgeons would soon be competent to discharge the duties thoroughly ; farmers and others would soon appreciate and consent to the inspection, which must be thorough.

The voluntary inspection of cattle, on farms of milk associations of Denmark and Sweden, are of great advantage.

The inspection should be systematic, at frequent intervals, because of the insidious nature and rapidity of the invasion of the disease.

No tubercular cow should be allowed to remain in a dairy supply, and every cow with any disease of the udder should be isolated and kept under careful observation, and all dairy premises and cattle should be registered (196).

The STERILISATION of TUBERCULAR MATERIAL.

In order to answer the question under what conditions can tubercular material be rendered innocuous, the material used was often of greater virulence than that of the natural tubercular milk.

It must be assumed that man is as susceptible to the disease as the most susceptible animal, as the disease in both infects at the same points.

Tables LXXII. and LXXIII. give, at a glance, the outside limits of infection of material at certain temperatures.

Table LXXIV. shows the limits of time and temperature at which positive results were obtained with heated, artificial, or natural milk.

The feeding experiments on pigs show the necessity for prolonged heating in order to sterilise milk.

The experiments on cats gave very varied results (197–201).

PART X.

DETAILS of POST-MORTEM EXAMINATIONS of COWS from which TUBERCULAR MEAT and ORGANS were obtained for EXPERIMENTS, with DETAILS of EXPERIMENTS on ANIMALS, p. 181.

PART XI.

COOKING (ROASTING) EXPERIMENTS with MEAT purposely rendered INFECTIVE by the addition of obviously TUBERCULAR MATERIAL ("SMEARED" MEAT), p. 209.

PART XII.

DETAILS of FEEDING AND INJECTION EXPERIMENTS with TUBERCULOUS MILK from FOUR COWS suffering from TUBERCULOUS UDDERS.

PART XIII.

DETAILS of EXPERIMENTS made with MILK artificially rendered VIRULENT by the addition of manifestly TUBERCULAR MATERIALS.

ROYAL COMMISSION ON TUBERCULOSIS.

INQUIRY I.

As to the means of Recognising Tuberculosis in Animals during Life.

Report by John McFadyean, M.B., C.M., B.Sc., F.R.S.E., Principal and Professor of Comparative Pathology and Bacteriology at the Royal Veterinary College.

1 The experiments and observations made under this head were specially directed to ascertaining the value of—

(1.) Attempts to discover tubercle bacilli in the bodies of affected animals, or in their secretions or excretions.
(2.) Ordinary clinical methods of examination.
(3.) Tuberculin.

Part I.

The Detection of Tubercle Bacilli during Life.

2 This is a method of diagnosis that can be put into practice in a considerable number of cases, although it has by no means so wide a range of application as might at first sight be supposed. The restriction of its applicability is due (1) to the fact that tubercle bacilli are generally confined to the actual lesions; and (2) to the fact that in many cases the primary lesions are situated in parts of the body that are not accessible to examination.

3 *The blood.*—As is well known, it is believed by some that tuberculosis of cattle is a disease in which, in a great many if not the majority of cases, the whole body is contaminated. If that view were correct, it would follow that it ought to be possible to demonstrate the presence of tubercle bacilli in the blood-stream, for if the entire body were contaminated or infective that could only be by the transport of tubercle bacilli in the circulating blood. Every one must admit that in a small proportion of cases of bovine tuberculosis (probably not more than 1 per cent.) the distribution of the tuberculous lesions indicates that at a given moment the blood-stream must have been the carrier of bacilli. These are the cases in which miliary tubercles are found in the lung, and also in the liver, spleen, or kidneys, and there can be no doubt that in such cases there must have been a time at which an examination of the blood would have put in evidence the presence of tubercle bacilli. But the possibility of demonstrating the presence of tubercle bacilli in the blood in cases of generalised miliary tuberculosis has very little practical importance, for, as already stated, that form of the disease is rare in cattle, and when it does occur the diagnosis can generally be made with tolerable certainty from clinical characters alone.

4 Against the view that an examination of the blood might usefully be resorted to in practice as an aid to diagnosis of ordinary cases of tuberculosis, the following experiments are conclusive.

5 *Experiment I.*—Blood was withdrawn during life from the jugular vein of a cow known to be the subject of tuberculosis. The disease was located in the pharyngeal and prescapular lymphatic glands, which were enormously enlarged. The blood after defibrination was injected in doses of 6·8 cc. each into the peritoneal cavity of three rabbits. At each step in the operation strict precautions against accidental contamination were taken. The rabbits were killed 41 days after inoculation, and found to be free from tuberculosis.

6 *Experiment II.*—This experiment was a repetition of the preceding one, save that only two rabbits were inoculated and that the quantity of blood injected into each was 5 cc. The cow from which the blood was taken was found on post-mortem examination to have very extensive tuberculous lesions in the lungs and bronchial glands. The rabbits were killed 40 days after inoculation, and the result was again negative.

7 It may be observed that in the first of these experiments the cow from which the blood was taken had that glandular form of the disease which is sometimes erroneously regarded as evidence of generalisation of the disease, and yet by the severest test at our command it was impossible to discover evidence that the blood contained tubercle bacilli.

8 As still stronger evidence of the futility of examining the blood in tuberculosis, I may here cite three other experiments. These consisted in first injecting enormous numbers of virulent tubercle bacilli into the jugular veins of horses, and then after a lapse of 24 to 48 hours withdrawing a quantity of blood, defibrinating it, and injecting it into the peritoneum of guinea-pigs, 5 cc. to each animal. The guinea-pigs were killed 23 to 34 days after inoculation, and in every instance the autopsy failed to reveal a trace of tuberculosis in any part of the body. It is therefore evident that even when, as at the starting point of a generalised tuberculosis, great numbers of tubercle bacilli find their way into the blood-current, they do not continue to make the round of the circulation, but within a comparatively brief period become filtered out in the lungs and other organs of the body. Hence, even in the worst cases of tuberculosis an examination of the blood could only by a happy accident warrant a positive diagnosis, and in no circumstances would it justify the conclusion that the animal was free from tuberculosis.

9 *Milk.*—By an examination of the milk a positive diagnosis may readily be made in cases of tuberculosis of the udder. The number of bacilli present in the milk is very variable. Sometimes in cover-glass preparations they are present in every field of the microscope, while in other cases very careful searching is necessary to find a single bacillus. I have never found the bacilli numerous while the milk still retained its normal appearance. They are discoverable without difficulty when the milk has become thin and watery, and when it deposits on standing a considerable amount of precipitate. In the latter case the discovery of the bacilli is facilitated by submitting the milk to the action of a separator, and examining the sediment. This is true also in cases where the milk is but little altered in appearance, but bacilli are then present in the cream as well as in the bottom stratum of milk. I have not found it of any advantage to examine the precipitate thrown down by adding acetic acid to the milk after dilution with water, as recommended by Johne.

10 While there can be no doubt that microscopic examination of the milk is a fairly reliable guide in mammary tuberculosis when the disease has progressed so far as to be detectable on manipulation of the udder, there must be a period at the commencement of the lesion when bacilli are so sparingly present that they would probably escape detection even by a most prolonged and careful microscopic examination. At this stage intra-peritoneal inoculation of the suspected milk would be a far more certain but less rapid method of proving the presence of tubercle bacilli.

11 In connexion with this part of the subject there still remains to be discussed the very important question as to whether the milk ever or frequently contains tubercle bacilli when the mammary gland is not itself the seat of disease. If that question had to be answered in the affirmative, it is obvious that an examination of the milk, either microscopically, or by inoculation, would be of great value as an aid to diagnosis.

12 I have, in many instances, made a prolonged microscopic examination of milk from cows in advanced stages of tuberculosis, but with udders apparently sound, and in every case the search for tubercle bacilli has been unsuccessful.

13 But, of course, it might happen that while tubercle bacilli in milk from tuberculous cows with healthy udders escaped detection by any reasonably prolonged microscopic examination, they might still be proved present by a method of search which is admittedly more refined, viz., by inoculation experiments. The following five experiments bear upon that point.

14 *Experiment I.*—Milk from a tuberculous cow was injected into the peritoneal cavity of two guinea-pigs, 5 cc. to each animal. The milk was taken from the udder after the cow had been killed, and with strict precautions against accidental infection. The cow had most extensive tuberculous lesions affecting the pleura and peritoneum—both parietal and visceral—but the

udder appeared to be healthy, and the milk was of normal appearance. The two guinea-pigs were killed 25 days after inoculation, and found to be free from any sign of tuberculosis.

15 *Experiment II.*—The conditions in this case were exactly similar to those of Experiment I. The carcase of the cow that furnished the milk was condemned on account of advanced tuberculosis at the Edinburgh Abatteir. The result again was negative, both guinea-pigs being found healthy when killed 25 days after inoculation.

16 *Experiment III.*—The cow from which the milk was taken in this case had tuberculous lesions even more extensive than in the preceding two experiments, the pleura and peritoneum being covered with the so-called "grapes," and the liver and lungs being much affected. Two guinea-pigs received 5 cc. each of the milk by intra-peritoneal injection. They were killed on the 24th day of the experiment and found to be healthy.

17 *Experiment IV.*—In this case the cow had tuberculous growths on the left side of the chest-wall, for which the carcase was condemned at the Edinburgh Abattoir. The milk, which was rather thick and yellow, was again injected into the peritoneal cavity of two guinea-pigs in 5 cc. doses. The guinea-pigs were found to be healthy when killed 89 days after inoculation.

18 *Experiment V.*—In this case the milk was taken from the udder of a cow that was the subject of tuberculosis, with extensive lesions in the lungs and on the pleura and peritoneum. The two guinea-pigs, each of which received 5 cc. of milk into the peritoneum, were killed 84 days after inoculation, and found to be free from any appearance of tuberculosis.

19 In face of these five experiments, and especially since they are in harmony with those made by such reliable workers as Bang and Nocard, I am driven to conclude that tubercle bacilli are probably not present in the milk of cows except when the udder is itself the seat of tuberculous disease, and that, in any case, an examination of the milk, whether by the microscope or by inoculation, is quite useless as a means of diagnosis in cases of tuberculosis with the lesions elsewhere than in the mammary gland.

20 *Expectorate.*—The word "expectorate" is here used in its literal sense. In cattle, as in man, cough is a frequent, if not a constant, symptom of pulmonary tuberculosis, and in the act of coughing mucus and other matters in the bronchi are expelled through the glottis. In part such matters are ejected by the mouth, but in much greater proportion they are arrested temporarily in the mouth or pharynx, and afterwards swallowed.

21 The immense service to diagnosis which has been rendered by a microscopic examination of the sputum in cases of pulmonary consumption in man is well known, and this would naturally suggest a resort to the same method of examination in tuberculosis of cattle.

22 Although there is just as much reason to expect that bronchial mucus would contain tubercle bacilli even when the lungs are free from disease as that the milk of a non-tuberculous udder would contain such bacilli, no one has suggested that an examination of the expectorate would be of any service except in tuberculosis with lesions in the lungs or air-passages. In order to test the value of such an examination in cases of that kind, I collected mucus from the throats of four cows which were subsequently proved by post-mortem to have tuberculous lesions in the lungs. The mucus was obtained by passing a probang, armed at its extremity with a small sponge, back through the fauces, and using this as a sort of mop to the walls of the pharynx. Cover-glass preparations were then made from the mucus, stained in the ordinary way, and submitted to microscopic examination. In the first of the three cases the cow's lungs were the seat of nodular tuberculous broncho-pneumonia, but the lesions were only of moderate extent. No tubercle bacilli were detected.

23 In the second case both lungs contained numerous areas of tuberculous broncho-pneumonia. No tubercle bacilli were detected in the pharyngeal mucus.

24 In the third case the pulmonary lesions were unusually extensive. The anterior half of the left lung was consolidated from chronic nodular tuberculous broncho-pneumonia, and throughout the posterior half here were scattered patches of the same kind. The right lung also contained scattered patches of tuberculous broncho-pneumonia, and at the base a cavity as large as a goose-egg and filled with caseo-purulent material. Tubercle bacilli were discovered in the pharyngeal mucus of this cow, but in very small numbers.

25 In the fourth case both lungs contained numerous areas of tuberculous broncho-pneumonia. No tubercle bacilli were discovered in the expectorate.

26 In two of the three cases in which the search was unsuccessful (2nd and 4th) the pulmonary and other lesions were very extensive, and an almost certain diagnosis could have been made by ordinary clinical methods. That is true also of the 1st case, although the lung lesions were only of moderate extent; while in the one instance (the 3rd) in which the search was successful the lung lesions had about reached the limit compatible with life, and there was an actual tuberculous cavity, which, it may safely be said, is not met with once in 1,000 cases of bovine tuberculosis.

27 The failure to detect tubercle bacilli in three of the above four cases proves clearly enough that little is to be expected in the way of diagnosis from a microscopic examination of the expectorate in tuberculosis of cattle.

28 A microscopic examination might reveal tubercle bacilli in cases with extensive lung lesions, but, on the other hand, it would form a very uncertain guide to diagnosis in the generality of cases of pulmonary tuberculosis, and it would be quite useless in those cases in which the lungs are not tuberculous.

29 Nocard and Greffier* carried out experiments with the object of testing the practical value, as an aid to diagnosis, of collecting pharyngeal mucus from suspected animals and inoculating it to guinea-pigs, either subcutaneously or intra-peritoneally. The mucus was taken from the throats of cattle found to be affected with pulmonary tuberculosis at the autopsy, and in eight out of 11 cases it proved infective, while in the remaining three the result was negative. This method, it may be inferred, is much more certain than the mere microscopic examination of expectorate, but, on the other hand, it is too slow in yielding results to be of much value in practice, and it would be of no use in detecting any other than the pulmonary form of tuberculosis.

30 Examination of the expectorate as a means of diagnosis is far less serviceable in bovine than in human tuberculosis, mainly because the disease in cattle very seldom assumes the destructive form exemplified in pulmonary phthisis of the human subject. It is very rare to find extensive softening of lung tissue with the formation of actual cavities in tuberculosis of cattle, and, except in that form of the disease, it is probable that the expectorate never contains tubercle bacilli in large numbers.

31 *Other Secretions.*—The question of searching other secretions or discharges than those already referred to for tubercle bacilli may be dismissed in a few words. In cases of tuberculosis of the uterus tubercle bacilli may easily be found by microscopic examination in the discharge from the vulva, and it is possible that the same method might reveal their presence in urine or semen in tuberculosis of the kidney or testicle. But cases of tuberculosis with lesions in the organs just mentioned form a very small proportion compared with cases in which these organs are free from the disease, and hence the examination of genito-urinary discharge for tubercle bacilli is of very little practical interest.

32 *Exploratory Puncture.*—This method is of considerable value. It is true that in mammary tuberculosis an examination of the milk will usually reveal tubercle bacilli, but one sometimes meets with suspicious cases of mastitis in which scarcely a drop of secretion is obtainable and in which there is no reliable clinical history. In such cases it is easy with a hollow exploring needle to gouge out a small piece of the indurated gland and submit it, or scrapings from it, to microscopic examination. In this way I have found it possible to demonstrate tubercle bacilli in far greater numbers than by staining milk from the same udder.

33 The method is also applicable to the examination of enlarged and indurated lymphatic glands, such as the pharyngeal and prescapular, and by this means one may promptly distinguish between the glandular lesions of tuberculosis and those of actinomycosis when

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* Recueil de Med. Vet., August 1890.

a differential diagnosis is not clear on other grounds. The great objection to exploratory puncture as aid to diagnosis is that it cannot be carried out without the consent of the owner, and those who object even to a compulsory inspection of their cows would not be likely to sanction this operation, although when properly performed it is simple and harmless.

Part II.

Diagnosis of Tuberculosis by Ordinary Clinical Methods.

34 In discussing the diagnosis of tuberculosis, whether by ordinary clinical or other methods, it is well to keep in mind that there are two very different circumstances under which a veterinary surgeon may be called upon to say whether an animal is affected or not. He may, in the first place, have to make a differential diagnosis in the case of an animal that is already ill, and regarding which his advice is sought by the owner; or, secondly, he may as a veterinary inspector be called upon to detect the disease in animals that are reported by their owner to be, in his opinion, healthy. The difference between the two cases is really as regards the stage of the disease at which the diagnosis has to be made, for in ordinary practice the veterinary surgeon is seldom consulted regarding a tuberculous animal until the disease is well advanced, but in most cases tuberculosis is in existence for months before there is any disturbance of health sufficient to attract the notice of the owner or the attendant, and the veterinary inspector may be expected to detect the disease even at this early stage. It is obvious that if there is any difficulty of diagnosis in the first of those conditions, that difficulty will be very much greater in the second. The difference may be fairly illustrated by considering (1) what are the lesions commonly found at the post-mortem of animals that die from tuberculosis, or are killed as being hopelessly affected with it, and (2) what are the lesions of tuberculosis most commonly met with in the carcases of cattle killed in the ordinary way for food, and supposed to be healthy at the time of slaughter.

35 Regarding the first of these points it is not possible to obtain reliable statistics that refer to large numbers, but it may safely be asserted that the lungs are the seat of disease in 80 per cent. of the cases of tuberculosis in cattle in which veterinary surgeons are called in by the owner. But it is equally certain that in cases that are fatal through pulmonary lesions the disease is never confined to the lungs. The bronchial and mediastinal lymphatic glands are, without exception, diseased, and in the majority of cases the pleura, or both pleura and peritoneum, as well as the presternal and supra-sternal glands are simultaneously affected. In a smaller proportion of cases pulmonary tuberculosis is associated with disease of the mesenteric glands, liver, kidney, or mammary glands.

36 But the lesions of tuberculosis have a very different distribution when we take account, not merely of the animals about which veterinary advice is sought, but of all cases in which tuberculosis in any degree is brought to light by a reasonably careful post-mortem examination. The experience gained during the past few years in connexion with meat-inspection, particularly in the large German slaughter-houses, where the search for tuberculous lesions is very thorough, has proved that the disease is exceedingly common among cattle that pass for healthy at the time of slaughter. In Leipzig the proportion has been found as high as 33 per cent. of all adult cattle slaughtered there, and in this country upwards of 12 per cent. of the cattle killed under the Pleuro-pneumonia Slaughter Order in 1890–91 were found to be tuberculous. And when one analyses these cases it is found that in the great majority of them the lesions are slight, and confined to the thoracic lymphatic glands, or to these and the lungs.

37 Regarding the differential diagnosis of tuberculosis in animals that exhibit pronounced systems of illness little need be said. An absolutely certain diagnosis can seldom or never be made by ordinary clinical methods, but in the pulmonary form of the disease, which is by far the commonest, the history of the case, the emaciation, the symptoms pointing to disease of the lungs, and the evidence yielded by percussion and auscultation, make up a picture that can be confounded with that afforded by few other diseases.

38 It is of much more interest to inquire with what success one can use ordinary clinical methods in the detection of tuberculosis when no history is obtainable, and when to ordinary observation, such as that of the owner or attendant, the animal would pass for healthy.

39 *Temperature.*—First, it may be asked whether thermometric observations are of any use in this connexion. The answer must be in the negative. The great majority of tuberculous animals—that is reckoning every animal that is affected, in however small a degree—have a perfectly normal temperature, or one in which the variations are so slight as to have no diagnostic value. The hundreds of observations regarding temperature that have been published in connexion with tuberculin experiments absolutely settle that point.

40 *Physical Examination of the Chest* is of little use for the detection of lesions that are not translated by actual symptoms. Auscultation and percussion are powerless to detect tuberculous changes in the bronchial or mediastinal lymphatic glands, or small lesions in the lungs, and yet these are often the only lesions that exist while the animal retains the ordinary signs of health.

41 *Physical Examination of the Abdomen.*—In cattle rectal exploration is about the only means of physical examination that can be applied to the abdomen and its contained organs, and, except for the detection of extensive *perlsucht* growths on the peritoneum, it is of no value.

42 *Examination of the Superficial Groups of Lymphatic Glands.*—A very exaggerated importance has by some been attributed to this method of examination, the exaggeration arising from the belief that in tuberculosis the virus is diffused throughout the entire system and specially affects the lymphatic glands. This view is certainly erroneous as regards bovine tuberculosis. Undoubtedly certain groups of lymphatic glands are very frequently the seat of tuberculous changes, but with just as much constancy other groups escape, even in animals that have the most extensive lesions elsewhere. The explanation is simple. The only groups of lymphatic glands that are commonly affected are those that guard what may be termed the common ports of entrance of the bacilli. Named in order of the frequency with which they are affected, these are, the bronchial and mediastinal glands, the mesenteric glands, and the pharyngeal glands. The group last mentioned is the only one that is accessible to examination during life, and then only when the glands are considerably enlarged. Other five groups of glands can be felt during life, viz., the sub-maxillary, parotideal, prescapular, precrural, and supra-mammary. The last-mentioned gland is constantly affected in tuberculous mastitis, but the fact is of little diagnostic value, since it is frequently enlarged in other forms of mammary inflammation. In short, the characters of the lymphatic enlargement are less distinctive than those of the udder lesion in mammary tuberculosis.

43 Enlargement of the sub-maxillary, parotideal, prescapular, and precrural groups is easily detected, but those groups are affected in only a small proportion of cases.

44 The diagnostic value of glandular enlargement may be summed up by saying that when such enlargement is detected it is suspicious (and exploratory puncture of the gland might then warrant a positive diagnosis); but, on the other hand, the absence of any discoverable alteration in the accessible lymphatic glands affords not the slightest guarantee that the animal is not tuberculous elsewhere.

45 With a view to ascertaining the value of what may be termed the ordinary method of inspection in the detection of tuberculosis, I examined over 1,600 cows in the Edinburgh byres in the summer of 1892. Each animal was individually examined as regards its general condition and appearance, the state of the superficial groups of lymphatic glands, and the condition of the udder.

46 The main results of this inspection of the Edinburgh dairy cows may be summed up thus. About 50 cows were the subjects of inflammation of the udder, or gave evidence of having suffered from that some time previously. In the majority of these cases the history and the physical character of the inflamed gland were regarded as sufficient to indicate that the disease was not tuberculous. In 18 of the cases it was considered necessary to have recourse to a microscopic examination of the milk, and in one instance a piece was gouged out of the diseased quarter, but in no case were tubercle bacilli discovered. As regards this search for tubercle

bacilli it may be as well to state that the milk stained and examined in each of these cases would be equal to about six or eight ordinary cover-glass preparations. In reality the milk was generally spread not on cover-glasses but on microscopic slides (3 inches × 1½), and, after staining by the Ziehl-Neelsen method, the film was searched carefully with an oil immersion lens (Reichert's 1/15).

47 In only four cases was there any noticeable enlargement of the superficial groups of lymphatic glands (supra-mammary excluded) and only some six or seven were in such poor condition as to be open, on that ground, to a suspicion of tuberculosis. It might be inferred from the results of this examination that the 1,600 animals inspected were, for milch cows, unusually free from tuberculosis, but it is almost certain that such an inference would be altogether erroneous, since of the cows killed in Edinburgh under the Pleuro-pneumonia Slaughter Order in 1891 about 20 per cent. were found on post-mortem examinations to be affected with tuberculosis. The conclusion that appears warranted is, that ordinary clinical examinations is almost valueless for the detection of tuberculosis in its early stages.

Part III.

Tuberculin.

48 *Lot I.*—The following lot of animals comprised 20 milch cows of various ages which had to be slaughtered owing to their having been in contact with a case of pleuro-pneumonia. They were in poor condition. Five cc. of tuberculin were divided between the 20 animals, the average dose being thus ·25 cc.; but two cows (Nos. 10 and 20) received rather more than their share. The injection was made on the 15th October 1892, at 9.0 a.m., and the animals were slaughtered on the following day.

Number.	14th October.		15th October.						16th October.		Result of Post-Mortem.*
	10.0 a.m.	7.0 p.m.	9.0 a.m. (Injected.)	12.0 noon.	3.0 p.m.	6.0 p.m.	9.0 p.m.	12.0 mid-night.	3.0 a.m.	6.0 a.m.	
1	101·0	101·50	101·50	101·25	101·25	102·0	101·50	101·75	101·0	101·0	+
2	101·25	101·25	101·50	101·0	101·25	101·75	100·75	101·0	101·0	101·0	+
3	101·0	101·0	100·50	100·75	101·25	101·50	101·0	102·50	102·50	101·75	+
4	101·25	102·0	101·0	100·50	101·0	100·75	99·50	100·50	100·25	100·0	—
5	101·25	101·25	100·25	101·0	101·25	101·25	101·0	101·0	101·50	101·0	—
6	100·75	102·0	101·50	101·0	101·25	101·25	101·0	101·50	102·50	101·50	+
7	101·75	100·75	101·25	101·0	101·0	101·0	100·50	102·0	102·0	101·75	+
8	101·25	102·0	101·50	101·0	101·0	101·25	100·0	100·0	100·0	101·0	+
9	101·25	101·75	100·75	101·0	101·75	102·0	101·75	104·0	104·0	103·0	—
10	100·50	101·0	100·50	100·75	100·0	102·50	102·0	104·0	104·0	104·50	+
11	101·0	101·75	101 25	101·0	101·25	101·0	100·50	99·50	98·0	98·0	+
12	100·75	101·25	101·75	101·0	101·0	101·50	102·0	105·0	104·50	104·0	+
13	102·25	102·75	101·50	101·25	101·75	101·50	100·0	100·0	100·0	100·0	—
14	100·25	100·50	101·25	100·50	101·50	101·0	101·0	102·50	104·50	104·0	+
15	101·25	101·50	101·0	99·75	101·25	100·75	100·75	100·75	101·50	101·50	+
16	102·0	101·25	100·75	101·25	101·75	101·50	102·0	101·0	101·0	100·50	—
17	101·25	101·0	101·0	101·0	101·50	101·50	101·25	102·50	103·25	102·50	+
18	101·0	101·25	100·50	101·0	101·50	100·75	100·50	100·0	99·0	99·50	—
19	101·25	101·50	101·50	101·75	101·50	101·50	102·0	101·0	101·0	101·50	—
20	102·0	100·75	100·50	101·50	101·0	101·50	104·0	104·50	105·0	104·0	+

* The sign + means tuberculous; —, non-tuberculous.

49 The following table refers to the animals of Lot I. in which the temperature after injection reached 103° at least.

Number.	Maximum Temperature.	Rise of Temperature.	Tuberculous Lesions discovered.
	°	°	
9	104·0	3·25	None.
10	104·0	3·50	Slight in lung and extensive in bronchial and mediastinal glands.
12	105·0	3·25	In mediastinal glands.
14	104·50	3·25	In right kidney and mediastinal glands.
17	103·25	2·25	In both lungs; liver; and bronchial, mediastinal, and mesenteric glands.
20	105·0	4·50	In mesenteric glands.

As the above table shows, in 6 out of the 20 animals in this lot, the temperature after injection reached 103° or more, the elevation varying from 2·25° to 4·50°. Five of these animals were found to be tuberculous, and in the sixth no tuberculous lesions were discovered.

50 The following table refers to the animals of Lot I., in which the temperature after injection remained under 103°.

Number.	Maximum Temperature.	Rise of Temperature.	Tuberculous Lesions found.
	°	°	
1	101·75	0·25	In bronchial and mediastinal glands.
2	101·75	0·25	On peritoneum of liver, and in bronchial and mediastinal glands.
3	102·50	2·0	In left lung and mediastinal glands.
6	102·50	1·0	In bronchial glands.
7	102·0	0·75	„ „
8	101·25	0·0	In mediastinal glands.
11	101·25	0·0	In bronchial glands and kidney.
15	101·50	0·50	In liver and bronchial glands.
4	101·0	0·0	None.
5	101·25	1·0	„
13	101·75	0·25	„
16	101·75	1·0	„
18	101·50	1·0	„
19	101·75	0·25	„

It will be observed that 8 out of the 20 animals were found to be tuberculous, although the temperature after injection in none of them reached 103°, and in only one rose 2°. In the remaining six cows the highest temperature after injection was 101·75°, and the greatest rise 1°, and in none of these were any tuberculous lesions discovered.

51 *Lot II.*—The following lot was made up of 19 cows and a yearling bull (No. 20), which formed part of the same herd as Lot I. The average dose of tuberculin given was ·25 cc.; but No. 25 received nearly double that quantity. The injection was made on the 13th October, at 9.0 a.m., and the animals were killed on the following day.

Number.	12th October.		13th October.						14th October.		Result of Post-Mortem.
	9.30 a.m.	7.30 p.m.	9.0 a.m. (Injected.)	12.0 noon.	3.0 p.m.	6.0 p.m.	9.0 p.m.	12.0 mid-night.	3.0 a.m.	6.0 a.m.	
21	101·0	101·50	101·0	101·25	101·50	101·50	100·0	101·0	100·75	101·0	+
22	101·75	101·75	101·75	101·75	102·25	101·0	103·0	103·0	104·0	105·0	+
23	101·0	100·75	100·75	102·0	101·50	101·0	100·0	100·0	98·50	98·50	–
24	101·25	102·0	100·75	101·25	101·50	100·75	100·50	100·75	100·0	100·0	–
25	102·0	102·0	101·25	100·75	101·25	101·0	101·0	101·0	101·0	101·25	–
26	101·0	102·25	100·25	100·75	101·25	101·0	102·0	105·0	103·0	102·50	+
27	101·0	101·25	100·75	101·25	101·50	101·75	102·0	103·25	104·0	103·50	+
28	101·75	103·75	101·25	102·0	101·0	102·50	105·0	105·25	101·50	102·0	+
29	101·50	101·0	103·0	103·75	103·75	102·75	104·25	103·50	102·0	102·75	–
30	101·75	101·0	101·25	101·50	101·75	103·0	105·0	104·0	103·50	104·0	+
31	101·25	101·25	101·25	101·25	102·0	101·0	100·50	100·50	100·50	100·50	–
32	101·75	102·0	100·75	101·75	101·75	101·50	102·0	102·0	102·0	101·0	–
33	100·50	100·75	100·75	101·25	101·50	101·0	101·25	103·0	102·0	102·0	+
34	101·0	102·0	100·50	100·75	101·50	100·50	101·75	102·50	102·0	102·0	–
35	100·0	101·25	100·25	101·25	101·75	101·0	101·0	103·50	101·50	101·50	–
36	101·75	102·0	100·25	100·50	101·25	101·25	103·0	102·0	101·0	101·50	–
37	102·0	102·0	100·75	100·75	101·25	100·75	100·50	100·75	100·50	99·50	+
38	101·0	103·0	101·25	102·50	104·0	104·50	104·0	104·50	103·0	102·25	+
39	101·0	101·50	100·75	101·0	101·0	101·50	101·75	101·75	104·0	103·0	–
40	102·0	102·0	101·25	101·75	101·0	101·0	100·75	100·0	100·50	101·0	–

52 The following table embraces the animals of Lot II. in which the temperature after injection reached 103° or more.

Number.	Maximum Temperature.	Rise of Temperature.	Tuberculous Lesions found.
	°	°	
22	105·0	3·25	In bronchial and mediastinal glands.
26	105·0	4·75	In lung (slight).
27	104·0	3·25	In bronchial and mediastinal glands.
28	105·25	4·0	In bronchial and mediastinal glands.
29	104·25	1·25	None.
30	105·0	3·75	In mesenteric glands.
33	103·0	2·25	In pleura.
35	103·50	3·25	None.
36	103·0	2·75	„
38	104·50	3·25	In lung.
39	104·0	3·25	None.

As shown above, out of the 20 animals in this lot, 11 had a temperature reaction up to 103° or more, the rise after injection varying from 1·25° to 4·75°. In 7 of those 11 animals the post-mortem revealed tuberculous lesions, and in the other 4 it did not.

53 The following table refers to the animals of Lot II. in which the temperature after injection did not reach 103°.

Number.	Maximum Temperature.	Rise of Temperature.	Tuberculous Lesions found.
	°	°	
37	101·25	0·50	In liver.
21	101·50	0·50	In bronchial glands.
23	102·0	1·25	None.
24	101·50	0·75	„
25	101·25	0·0	„
31	102·0	0·75	„
32	102·0	1·25	„
34	101·75	1·25	„
40	101·75	0·50	„

The above table shows that in 9 out of the 20 animals composing Lot II. the temperature after injection remained under 103°, and that the rise varied from 0 to 1·25°. The post-mortem examination revealed tuberculous lesions in two of the nine animals, and failed to reveal such lesions in the remaining seven.

54 *Lot III.*—This was a herd of 25 farm cows, also condemned on account of having been in contact with a case of pleuro-pneumonia. They were rather poor in condition. No. 65 received ·75 cc. of tuberculin; Nos. 46, 51, 54, 56, 57, 59, 60, and 61 received ·20 cc. each; while the remainder had ·30 cc. each. The injection was made at 9 a.m. on the 17th October, and the animals were killed on the following day.

Number.	16th October.		17th October.					18th October.		Result of Post-mortem.
	5.0 a.m.	2.0 p.m.	9.0 a.m. (Injected.)	12.0 noon.	3.0 p.m.	6.0 p.m.	12.0 mid-night.	3.0 a.m.	6.0 a.m.	
41	100·0	100·50	101·50	101·75	100·75	101·50	100·75	101·0	100·50	−
42	101·50	103·0	101·50	101·50	101·50	101·50	105·0	104·0	103·0	+
43	101·0	101·25	100·50	101·75	101·50	101·0	101·0	103·0	102·50	+
44	102·0	103·0	100·0	101·0	101·75	102·0	102·50	101·0	101·0	+
45	101·50	102·50	100·50	101·25	102·25	101·50	101·0	101·0	100·0	+
46	101·25	101·50	100·25	101·25	100·75	101·25	104·0	104·0	102·50	+
47	101·25	101·50	100·50	101·75	101·50	100·75	105·0	105·0	104·50	+
48	101·0	101·25	101·0	101·25	101·25	101·0	100·0	100·0	100·75	+
49	101·50	101·50	100·50	101·25	101·0	101·50	104·50	105·0	103·75	+
50	102·0	101·75	101·25	101·50	102·0	103·0	104·0	103·75	104·0	+
51	100·25	101·0	101·25	100·75	100·75	102·0	102·75	102·0	101·75	−
52	100·50	101·0	100·50	101·25	100·75	101·0	105·50	104·0	102·0	+
53	101·25	101·0	100·50	100·50	101·75	102·0	103·0	102·0	102·50	+
54	101·0	101·0	101·0	101·25	101·25	101·0	101·0	100·75	101·50	−
55	101·50	101·50	100·75	101·50	101·50	102·0	101·0	101·25	101·0	−
56	101·50	101·50	99·75	101·50	100·50	101·50	101·50	101·0	102·0	+
57	101·50	102·0	101·25	100·75	101·0	102·50	101·0	100·0	100·0	−
58	101·25	101·25	101·0	101·50	101·50	101·50	100·0	100·75	101·0	+
59	101·0	101·0	100·50	101·25	101·0	101·0	100·50	100·0	100·0	−
60	101·25	101·25	100·0	101·25	100·75	101·50	98·50	99·0	98·50	+
61	100·50	101·0	101·25	101·50	101·0	101·25	101·0	100·0	101·50	+
62	100·25	102·0	100·0	101·50	101·25	101·0	100·0	99·75	100·0	+
63	100·25	100·25	100·75	100·25	101·0	102·0	100·0	99·50	99·50	+
64	100·0	100·25	100·50	101·25	100·50	101·75	100·50	99·0	100·0	+
65	100·50	101·50	101·0	100·75	100·75	101·50	100·0	100·0	100·50	−

55 The following table includes the animals of Lot III. in which the temperature after injection rose to 103° or more.

Number.	Maximum Temperature.	Rise of Temperature.	Tuberculous Lesions discovered.
	°	°	
42	105·0	3·50	In liver, lungs, and bronchial, mediastinal, and mesenteric glands.
43	103·0	2·50	In sub-maxillary gland.
44	103·0	3·0	In peritoneum and liver.
46	104·0	3·75	In lungs and mediastinal gland.
47	105·0	4·50	In liver, and bronchial and mediastinal glands.
49	105·0	4·50	In bronchial, mediastinal, mesenteric, and sub-maxillary glands; and lungs.
50	104·0	2·75	In lungs, and bronchial and mediastinal glands.
52	105·50	5·0	In lungs, and sub-maxillary and mesenteric glands.
53	103·0	2·50	In lungs, and bronchial and mediastinal glands.

The above table shows that out of the lot of 25 animals nine registered a temperature of 103° or more after injection, the elevation varying from 2·50° to 5°, and that the post-mortem revealed tuberculous lesions in each of the nine.

56 The following table embraces the animals of Lot III. in which the temperature after injection remained under 103°.

Number.	Maximum Temperature.	Rise of Temperature.	Tuberculous Lesions found.
	°	°	
45	102·50	2·0	In lungs and liver.
43	101·25	0·25	In liver.
56	102·0	2·25	In lungs and mesenteric glands.
58	101·50	0·50	In lungs and liver, and mediastinal and mesenteric glands.
60	101·75	1·75	In liver.
61	101·50	0·25	In mesenteric glands,
62	102·0	2·0	In lungs.
63	102·0	1·25	In liver,
64	101·75	1·25	In sub-maxillary glands.
41	101·75	0·25	None.
51	102·75	1·50	„
54	101·50	0·50	„
55	102·0	1·25	„
57	102·50	1·25	„
59	101·25	0·75	„
65	101·50	0·50	„

The above table shows that in 16 out of the 25 animals in this lot the temperature after injection remained under 103°, and in only one of these did the rise equal 2°. Nevertheless nine of them were tuberculous, while no tuberculous lesions were found in the other seven.

57 *Lot IV.*—This was a herd of 39 milch cows, kept in the country under fairly good hygienic conditions. None of the cows had been bred on the farm, the herd being kept up by buying in fresh animals to take the places of those sold when "dry" and fat. During the autumn of 1892 five cows had been slaughtered within one month, and in each case the veterinary surgeon who attended the herd found extensive tuberculosis lesions. With the consent of the owner and the co-operation of the veterinary attendant, I injected the whole herd with tuberculin on the 3rd of October, the temperature of all the cows save one (No. 1.) having been taken twice on the previous day. This cow had been separated from the herd, as she was suffering from an attack of acute inflammation of the udder, and at the same time gave evidence of pulmonary tuberculosis. All the other cows were carefully examined, but in no case was any distinct symptom of tuberculosis discovered. In fact, with the before-mentioned exception, and one other (No. 15) cow in poor condition, all the members of the herd appeared in excellent health. They were in excellent condition, and according to the report of their attendant they all took their food well.

Each cow received one-third of a cubic centimetre of tuberculin, and the following table shows the temperature before and after the injection.

58

Number.	Before Inoculation.		After Inoculation with $\frac{1}{3}$ cc. Tuberculin.						
	Sunday 2/10/92.		Monday, 3/10/92.				Tuesday, 4/10/92.		
	9.0 a.m.	6.0 p.m.	11.0 a.m. (Injected.)	2.0 p.m.	5.30 p.m.	10.0 p.m.	1.0 a.m.	4.0 a.m.	7.0 a.m.
1	—	—	103·25	102·0	104·50	104·0	104·0	104·0	103·0
2	104·25	101·75	101·0	100·50	101·0	103·0	104·0	103·50	102·0
3	101·25	102·0	101·25	101·0	102·0	105·0	105·75	104·0	105·0
4	101·50	101·75	101·75	101·0	102·0	104·0	104·0	104·50	103·0
5	102·0	102·25	101·50	101·25	102·0	101·50	103·0	101·50	101·0
6	101·0	102·0	101·75	100·50	101·50	105·0	105·0	105·0	104·0
7	101·0	102·0	101·25	101·0	102·25	106·0	106·0	105·0	104·50
8	100·50	102·0	100·75	103·75	106·0	106·0	106·0	106·0	104·0
9	101·50	102·25	101·0	100·75	102·75	107·0	105·75	105·50	104·25
10	100·75	101·25	100·75	100·50	101·50	105·0	106·0	106·0	104·0
11	102·0	102·0	100·50	100·25	102·0	105·0	105·0	105·50	104·0
12	101·25	101·50	101·0	100·50	100·50	101·0	100·50	101·0	101·0
13	101·25	101·50	101·0	100·50	101·0	105·50	105·0	105·0	104·0
14	101·25	101·25	101·0	100·75	102·0	102·0	102·0	101·0	101·0
15	102·0	103·0	100·50	102·25	105·0	104·50	104·50	103·50	102·0
16	101·25	101·50	101·0	100·50	102·0	106·0	106·50	105·25	102·50
17	102·0	101·25	100·50	101·0	101·75	101·50	101·50	102·0	102·0
18	101·0	100·50	101·50	101·50	105·50	105·0	104·50	104·0	103·0
19	101·25	101·0	101·0	101·0	101·0	105·0	104·0	104·0	103·25
20	101·0	101·25	101·0	101·50	101·0	105·50	107·0	106·0	104·50
21	102·0	101·25	101·50	101·25	101·0	106·50	105·50	104·50	102·0
22	101·75	101·75	100·25	101·0	101·0	101·50	101·50	100·0	101·0
23	102·0	—	102·50	102·25	102·0	102·75	104·0	103·75	101·0
24	100·75	102·0	100·75	101·0	101·0	102·25	103·50	104·0	104·0
25	101·75	101·0	100·60	101·25	100·0	100·50	102·0	103·50	103·0
26	101·75	101·0	101·0	101·25	100·50	102·0	101·0	101·0	101·0
27	—	102·0	102·25	102·0	104·50	107·0	107·0	105·0	104·0
28	102·0	101·25	101·50	102·0	102·0	105·0	106·50	105·50	103·0
29	102·0	102·25	100·50	104·0	105·0	106·0	106·0	105·0	104·0
30	101·25	101·0	100·75	101·0	100·50	104·0	103·50	104·25	103·0
31	101·25	102·0	100·50	102·0	100·0	103·0	103·50	103·75	102·75
32	102·0	101·50	100·25	100·50	102·0	106·50	104·0	104·0	103·25
33	100·75	101·50	100·50	101·0	102·0	106·0	106·0	105·0	103·0
34	101·25	100·75	102·0	103·0	104·0	105·0	105·25	103·0	102·0
35	102·0	102·0	101·75	101·0	103·0	106·0	104·0	103·50	102·0
36	102·0	101·25	101·0	101·50	100·50	106·50	102·0	100·50	102·0
37	101·50	101·50	101·0	100·50	101·0	101·0	101·0	101·0	101·0
38	101·25	102·0	101·0	101·50	101·0	101·0	100·0	101·0	100·50
39	101·25	100·50	100·75	101·50	101·0	102·25	102·0	102·0	101·75

59 Having regard only to the temperature reaction the result of the injection of tuberculin in this herd was certainly startling, for in 31 out of the 39 cows the temperature rose to 103° or more—in fact, the tuberculin appeared to indicate that only eight animals in the herd were free from tuberculosis. In view of this result, and as the owner was anxious to eradicate the disease from the herd, it was suggested to him that the cows now under suspicion should be killed, two or three at a time, and beginning with those in which the temperature reaction had been most marked. Unfortunately for the value of the experiment this plan was only partially carried out, and I am therefore able to give particulars regarding only five of the cows, as follows:—

Number.	Maximum Temperature.	Rise of Temperature.	Result of Post-mortem.
9	107·0	6·0	Tuberculous.
15	105·0	4·50	"
7	106·0	4·75	"
6	105·0	3·25	"
1	104·50	1·25	"

60 It will thus be seen that the first five animals slaughtered within a few weeks after the injection with tuberculin were found to be tuberculous, and in all of these the temperature had exceeded 104°. It may therefore be said that in these five cases tuberculin had correctly indicated the existence of the disease, but it ought to be observed that in No. 1 the temperature was febrile before injection and afterwards rose only 1·25 degrees.

61 I have not included in the above list two other cows of the herd to which reference ought to be made. One of these (No. 16) was killed on the 2nd of March last, and found to be the subject of tuberculosis, but the interval of five months that had elapsed between the date of injection and slaughter made it impossible to say that the disease had been in existence at the former date. The other cow (No. 19) was killed about the 4th December, and parts of the udder and a lymphatic gland were kept by the butcher and forwarded to me. They showed no evidence of tuberculosis, but, of course, since no proper post-mortem examination was made, it would be rash to conclude that the animal was non-tuberculous. It is greatly to be regretted that an opportunity was not afforded to make a post-mortem of the other animals of the herd.

62 *Lot V.*—In October last I had sent to me enlarged and tuberculous lymphatic glands from the throat of a heifer, together with the following interesting history. The animal had formed one of a lot of nine pure bred shorthorn heifers, and it was the third of the lot that had been slaughtered on account of a serious difficulty of respiration caused by enlargement of the pharyngeal glands. The first had been killed in February 1892, and the second in the following August or September. The surviving six animals, which were from one and a half to two years old, were in splendid condition and free from any indication of tuberculosis. I visited the herd on the 22nd of October and injected each of the six heifers with tuberculin $\frac{1}{3}$ cc. to each. The local veterinary surgeon had taken the temperature of the animals twice on the previous day, and took it again at intervals after injection as shown in the following table:—

Number.	October 21. Morning.	October 21. Evening.	October 22, 3.0 p.m. Injected with Tuberculin.	October 22. 9.0 p.m.	October 22 Midnight.	October 23. 3.0 a.m	October 25. 9.0 a.m.	October 23. 3.0 p.m.
	°	°	°	°	°	°	°	°
1	101·5	102·2	102·2	103·0	104·8	104·2	103·5	102·5
2	101·4	102·0	102·0	103·4	105·0	105·2	105·4	104·5
3	102·2	102·6	102·2	105·0	107·0	106·0	105·0	104·4
4	101·6	102·5	102·0	103·0	102·5	103·8	103·4	102·4
5	102·0	102·4	102·0	102·4	105·2	105·8	104·8	104·4
6	102·5	103·0	102·6	104·5	104·5	103·4	102·6	102·5

63 These six heifers were killed at different dates, the last early in December, and with one exception they were submitted to a post-mortem examination by the local veterinary surgeon, and found to be tuberculous. Owing to a misunderstanding, no examination was made of No. 1 after slaughter. In the five that were found to be tuberculous the bronchial glands were affected in most, the lungs and liver in some, and the peritoneum in one (No. 6).

64 *Lot VI.*—This comprises only two cows, both of which were in the last stages of tuberculosis from most extensive lesions affecting both thoracic and abdominal viscera.

Number.	October 23.	October 24, midnight. Received $\frac{1}{3}$ cc. Tuberculin.	October 25. 6.0 a.m.	October 25. 9 a.m.	October 25. 12.0 noon.	October 25. 3.0 p.m.	October 25. 6.0 p.m.	October 25. 6.0 p.m.
	°	°	°	°	°	°	°	°
1	101·8	102·0	101·0	102·6	104·4	104·6	102·6	102·6
2	103·6	103·6	104·6	103·6	104·4	105·0	104·0	104·6

65 Both cows were killed a few weeks afterwards, and the post-mortem revealed most extensive tuberculous lesions. Both may be said to have reacted to the tuberculin, although the temperature was already slightly febrile in No. 2.

66 A tabular view of the results of these six series of experiments with tuberculin may be presented thus:—

Lot.	Temperature rose to 103°.		Temperature remained under 103°.	
	Tuberculous.	Non-tuberculous.	Tuberculous.	Non-tuberculous.
1	5	1	8	6
2	7	4	2	7
3	9	0	9	7
4	5	0	0	0
5	4	0	0	0
6	1	0	0	0
Total	31	5	19	20

67 It may be observed that one animal in Lot 5 (No. 1) and another in Lot 6 (No. 2) are excluded from this table because the temperature was already 103° before injection. Excluding these, the total number of animals that were submitted to a post-mortem examination within a reasonable time after injection is 75, and if it were agreed to interpret a rise of temperature from about the normal to 103° or over as an indication of tuberculosis, and to regard an animal as non-tuberculous when the temperature remains under 103°, then it might be said that in these 75 cases tuberculin pointed out the existence of tuberculosis correctly in 31 cases, and wrongly in five, and that it indicated the non-existence of tuberculosis correctly in 20 cases and wrongly in 19. In other words the indication was right in 51 cases and wrong in 24.

68 It would, of course, not be justifiable to assert that in the five animals that had a distinct reaction and in which no tuberculous lesion was discovered, there may not have been some small lesion that escaped detection, but, on the other hand, the post-mortem examination was very carefully carried out. But even admitting that a small lesion of tuberculosis did exist somewhere in these five cases, it would still remain a rather serious objection to the employment of tuberculin in veterinary practice if it led to the condemnation and slaughter of animals in which no disease could be demonstrated at the post-mortem.

69 With regard to the 19 animals in which the temperature remained under 103° there does not appear to be any probability of error. The temperatures were most carefully taken, and in every instance in which the nature of the lesion appeared doubtful tubercle bacilli were demonstrated before deciding that the case was really one of tuberculosis. It therefore cannot be gainsaid that in 19 out of 51 tuberculous animals, tuberculin failed to excite a diagnostic elevation of temperature.

70 So much by way of summing up the points that are unfavourable to tuberculin. But on the other side it ought not to be forgotten that out of the 51 tuberculous animals included in the foregoing experiments probably not more than three or four could by the most searching physical examination have been certainly recognised as affected with tuberculosis.

71 Nothing has been said hitherto regarding any of the other effects of tuberculin besides the elevation of body temperature. Some of those who have reported regarding its use claim that both in respect of local reaction and general disturbance of the system after injection there is a marked difference between tuberculous and non-tuberculous animals. That opinion I am not able to corroborate. The general disturbance was seldom very noticeable in any of the animals, and the swelling at the seat of inoculation was also slight, and not markedly greater in the tuberculous individuals.

72 In conclusion, I have no hesitation in saying that, taking full account of its imperfections, tuberculin is the most valuable means of diagnosis in tuberculosis that we possess. The discovery of tubercle bacilli is, of course, the only means of arriving at an absolutely certain diagnosis, but that means of diagnosis, for reasons already set forth, has an exceedingly restricted sphere of application in veterinary practice. Without tuberculin even the sharpest and most experienced practitioner is powerless to detect tuberculosis in its early stages; with it, he will find it possible to detect the majority of cases even when the lesions are very slight. It is probable that by using the tuberculin test twice, with an interval of some days between the injections, the proportion of errors in diagnosis would be very small.

INQUIRY II.

As to Food of Tubercular Origin: its Infectivity to Lower Animals.

Report by Sidney Martin, M.D., B.S., B.Sc., F.R.C.P., Assistant Physician to University College Hospital, and to the Hospital for Consumption and Diseases of the Chest, Brompton.

Summary of the Results of the Investigation.

i The object of the investigation was to determine whether the meat and milk of tuberculous cows was infective. *i.e.*, capable of transmitting the disease. If these food products are infective, they undoubtedly are dangerous as articles of diet, and especially so in the case of milk which is usually consumed in an uncooked form. No mere anatomical investigation could decide this question. As the investigation showed, meat was found infective when no tuberculous lesion was discernible in it, and tubercle bacilli were not discovered in milk which proved infective. Experiments on animals, therefore, were necessary to decide the question. In the human being, the cases of tuberculosis to be ascribed to eating tuberculous material are primary tubercular ulceration of the intestine (and tabes mesenterica), and primary tubercular peritonitis.* Both these classes of cases must be the result of the eating of tuberculous material, and, therefore, the investigation of how far the food-products may be responsible for them, *i.e.*, in what degree these food-products of tuberculous cows are infective, becomes a question of great importance to the human race. The experiments were of two kinds, inoculation and feeding. The feeding experiments in this research are the most important; but the inoculation experiments have their value, since they are a ready test of the infectivity of any particular material. It requires a certain amount of tuberculous material to produce tuberculosis by feeding, and this amount is much larger than that required to produce the disease by inoculation, subcutaneously or into the abdominal cavity. It is, therefore, not a surprising result of some of the experiments that an inoculation experiment with meat or milk gave a positive result, while some of the feeding experiments with the same class of material were negative.

In conducting this inquiry into the infectivity of tuberculous food-products numerous hygienic precautions were necessary. The exact distribution of tuberculous infective material in the world is not known, nor is it at present possible to trace, in the vast majority of instances, the source of the material which produces tuberculosis in man and in cows. It is, however, known that tuberculosis is an acquired disease, and that there is a large amount of tuberculous infective material which comes from cases of tuberculosis, and which is never destroyed; such as the expectoration from cases of pulmonary tuberculosis ("phthisis") in man, the dejecta in cases of tubercular disease of the intestine in man and animals, and last, but not least, the tuberculous organs removed from cattle slaughtered for food.

ii The precautions taken to prevent any accidental infection of the experimental animals were as follows:—

1. The cages, sheds, and pig-styes were newly made, kept clean, and thoroughly disinfected after each experiment.
2. The feeding-pans and troughs were sterilized by boiling or in the furnace.
3. The food of the experimental animals was sterilized by boiling.
4. Precautions were taken to see that the experimental animals were free from tuberculosis.

The details of these procedures are given in the report, and need not be repeated here. These precautions were carefully observed during the whole course of the research.

The results of the investigation of the infectivity of the meat and milk may be briefly summarised.

iii A. *Meat.*—The meat of 21 cows was used for investigation, in two of which microscopical examination revealed a localised tuberculous lesion in the muscle of the rump.

Of the 48 animals inoculated with the meat or meat-juice, 10 became tuberculous; of 102 animals fed, six became tuberculous. These positive results were obtained from the meat of eight of the cows; so that the meat of only eight out of the 21 cows examined proved infective. The question, however, is not so simple as these figures show. The infectivity of the meat is to some extent dependent on the degree of tuberculosis of the cow. Sixteen of the cows were affected with tuberculosis in a mild or moderate degree; of the 35 animals inoculated with the meat of these, five developed tuberculosis, but of the 81 animals fed with the meat, not one developed the disease. It is clear, therefore, that although the infective material in the meat was present in sufficient quantity to produce tuberculosis in some cases by inoculation, there was not sufficient to produce the disease by feeding.

It is, moreover, noteworthy that the infective material present when tuberculosis followed inoculation with the meat of three cows was so small that in three of the experiments only a local tuberculosis developed.

In five of the cows examined, the tuberculosis was very advanced, and had spread to most of the organs of the body. The meat of these cows was much more infective than that of the first class; for of 13 animals inoculated, five developed tuberculosis, and of 21 animals fed, six developed the disease.

In the first class of cows, 16 in all, the subject of tuberculosis in a mild or moderate degree, the meat of four animals proved infective; in the second class of cows, five in all, the subject of advanced or generalised tuberculosis, the meat of four was found infective.

From a consideration of the results of the experiments with the meat, it is concluded that the infectivity of meat does not depend on any infective material present in the muscular tissue itself, but on contamination of the meat during the dressing of the carcase of a tuberculous animal, or during its removal from the carcase, by means of the knife, cloth, &c. which has become infected with tuberculous material.

iv The question of the condemnation of the carcases of tuberculous cows as unfit for food has to be considered on broader lines than that of the infectivity of the meat alone. It is quite clear, however, from the facts stated above that the carcases of all cows the subject of advanced tuberculous disease in most of the organs of the body ought to be condemned; all these carcases are wasted, and the meat gives tuberculosis both by inoculation and by feeding. In the other cases of tuberculosis of the cow, where the disease is limited to one body cavity, either to the lungs and thoracic lymphatic glands on the one hand, or to the intestines and abdominal organs on the other, the meat cannot be reasonably condemned on account of its infective properties. Some of these carcases, however, are unfit for human food, not only because the carcase is wasted, but also in the carcase as "dressed" by the butcher a tuberculous lesion is left, which is sold with the meat and, if eaten, would prove a great source of danger. The tuberculous lesions which may be left in the "dressed" carcase are "grapes"* on the parietal pleura, tuberculous kidneys, tuberculous lumbar and pelvic lymphatic glands, and tuberculous popliteal lymphatic glands. These lesions, with the exception of the first, are signs that the disease is becoming generalised in the cow. For these reasons, therefore, all such carcases ought to be condemned.

Other hygienic precautions are also necessary in the slaughtering and dressing of tuberculous cows. The infection of meat being dependent on contamination, greater care is necessary in the use of the butcher's knife, cloth, &c., to prevent the conveyance of the smeary tuberculous material not only to the meat of the tuberculous carcase but to that of a healthy one. Very little experience in a slaughter-house is sufficient to demonstrate this great danger of the conveyance of tuberculous material to the meat. The butcher's knife frequently incises a mass of "grapes" on the pleura, or a tuberculous gland in the thorax or a tuberculous lung; and no precautions are taken to cleanse the knife—naturally so, since it is not recognised in the slaughter-house that there is any danger from tuberculous lesions.

Again, every organ or other part removed from a tuberculous animal ought to be destroyed, whether healthy or diseased: and all condemned carcases ought to be destroyed or rendered innocuous by heat. In this way a large amount of infective material will be rendered incapable of transmitting the disease to animals and man.

v B. *Milk.*—The milk of tuberculous cows is divided into two classes:—(1) That given by tuberculous cows in which there is no tuberculous disease of the udder; (2) That given by tuberculous cows in which the udder is also tuberculous.

1. With the milk of 8 cows the subject of tuberculosis varying in degree from mild to advanced and

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* From the results of the feeding experiments in pigs, it seems probable that "strumous" glands in children may also be due to feeding with tuberculous food-products (*see* Part I., p. 16).

* "Grapes" is the term applied to the thick and bunchy tuberculous lesions of the pleura of the cow.

generalized, 28 animals were inoculated and 41 fed; not one developed tuberculosis.

2. With the milk of five cows the subject of tuberculosis of the udder of varying extent, 21 animals were inoculated; all developed tuberculosis. Twenty-seven animals were fed; 19 developed tuberculosis.

It is clear, therefore, that when tuberculosis of the cow affects only the internal organs of the body and not the udder, the milk is not infective; but that, in all cases where the udder is tuberculous, the milk becomes infective, and is, indeed, often extremely virulent. Moreover, the butter, buttermilk, and skimmed milk obtained from this class of milk is also extremely infective.

There is no question, therefore, that this class of milk ought not to be used as food; and it is, indeed, certain that its exclusion would lead to a great diminution in the large number of cases of tuberculosis that occur in children.

Many other questions are discussed in the Report which need not be summarised here; such as the course of tuberculosis in animals, the composition of the milk of tuberculous cows, the diagnosis of tuberculosis of the udder, and the diagnosis of tuberculosis in cows by means of Koch's tuberculin.

The Report is divided into nine parts:—

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PART I.

GENERAL: DESCRIPTION of PLACES of EXPERIMENT, and of the EXPERIMENTAL ANIMALS and their FOOD, and of the COURSE of TUBERCULOSIS in ANIMALS by FEEDING and INOCULATION.

1 The investigation was begun in April, 1891, and concluded in September, 1893. In conducting a continuous research during so long a period a great deal of help, expert and otherwise, was necessary in order that attention should be given to the great amount of detail requisite in carrying out the experiments. Throughout I have been very ably assisted. Nearly all the experiments were performed at Harrow, at the place of Mr. Sidney Villar, F.R.C.V.S. During the whole time Mr. Villar has been of great assistance in the general supervising of the houses, sheds, &c., and has been invaluable in procuring for the Commission tuberculous milch-cows. Without his aid the investigation would have occupied a much longer period.

In the scientific part of the investigation, I had at first the assistance of F. J. Wethered, Esq., M.D., M.R.C.P., and for a short time of A. G. Phear, Esq., M.D. (Cantab.), M.R.C.P.

Since January 1892, I have had the advantage of being assisted by Dudley Cooper, Esq., M.R.C.S., L.R.C.P., of University College Hospital. I cannot speak too highly of the help which Mr. Cooper has given to the investigation; equipped with a sound knowledge of pathology, he not only entered into the work with enthusiasm, but was invaluable in carrying out the details of the experiments, in accurately recording them, and in performing the very numerous post-mortem examinations of the experimental animals and of the tuberculous cows.

PLACES OF EXPERIMENT*: CAGES, SHEDS, FOOD OF THE ANIMALS, PRECAUTIONS TAKEN.

2 A few experiments were done at Denham Court by permission of H. Swithinbank, Esq.; but this was found too far from London for a continuance of the research.

Nearly all the experiments were done at Mr. Sidney Villar's place at Greenhill, Harrow. Here there was a wooden house for the guinea-pigs, three wooden sheds for cows, and 15 styes for pigs, and a small galvanized iron house used as a laboratory. These buildings were arranged a considerable distance from each other in a field.

They were all newly made, so that they had not been used for anything but the experiments of the Commission. The *guinea-pig house* was warmed in winter by a fire and boiler which was used for cooking the animals' food. It was ventilated by a door divided horizontally and a window at each end. The guinea-pig and rabbits' *cages* were limewashed inside. When all the experimental animals had died in a cage, this was scrubbed with boiling water and limewashed once or twice; the cage was not used again for several weeks.†

3 *Pig-styes* were made with cement flooring, and proper drainage, and with wooden tarred sheds. When an experimental pig died, the cement floor was well limed, washed and scrubbed, and the shed and railings re-tarred.

The *calves' and cows' sheds* were tarred outside and limewashed inside. They were thoroughly cleaned and limewashed after each animal was removed.

By these means all cages, styes, and sheds were kept hygienic; and there was no instance of a cage or stye which had contained a tuberculous animal transmitting the disease to an animal subsequently placed in it. It is obvious that unless the cages were properly disinfected, infection might be conveyed from one series of animals to the next, especially in the case of feeding experiments, where the intestines might be the seat of tuberculous lesions.

4 *Feeding-pans and troughs.* The feeding-pans of the guinea-pigs and rabbits were flat glazed earthenware dishes. They were well washed and sterilized every day by boiling for two hours. The pigs' troughs were of iron and were made red hot in the fire before being used for an experiment. The calves' buckets were newly made and scalded with boiling water before being used.

Moreover, in his daily visits the attendant first cleaned out the animals' cages, then washed his hands before feeding the animals with their ordinary food.

All these details were a matter of personal supervision on my part, and no detail was left to the discretion of the attendant.

Food of the experimental animals.

5 It was thought advisable, in order to insure against accidental contamination, to sterilize the food of the animals. This was done by boiling it for two hours. The guinea-pig food consisted of bran, oats, and grass mixed with water; it was found well to add to this some uncooked mangold and cabbage, the outer leaves of the cabbage being removed. Guinea-pigs do not thrive unless they have green food.

Pigs and calves were fed on boiled "calves' meal," a mixture of bean and pea-flour. Pigs had no other food than this; the calves were allowed hay, as they did not thrive without it. It may be said that with this diet all the animals did well, especially the pigs, calves, and rabbits. It is difficult to keep the guinea-pigs always in good condition. They died off in an unaccountable manner; although every effort was made as regards change of diet, regulation of temperature, &c., to keep them alive.

Experimental animals.

6 The animals used in the course of the investigation were *guinea-pigs, rabbits, pigs,* and *calves.*

All these are animals susceptible to tuberculosis; guinea-pigs and rabbits in the highest degree; pigs and calves to a less extent. It may be said that in all these animals a moderate dose of the virus will produce tuberculosis.

It was necessary to see whether the animals were free from tuberculosis before being used for experiment. This might be done in two ways; (1) by keeping the animal some time, one to two months, before being used, or (2) by keeping some of the animals as controls.

As regards *guinea-pigs* and *rabbits*, it is impossible to tell when these animals are tuberculous. It is in many cases quite clear after inoculation that the animal has developed tuberculosis from the enlargement of glands near the site of inoculation. But guinea-pigs and rabbits, when they develop tuberculosis after feeding, do not show any signs of the disease discoverable by the naked eye; no wasting or very evident signs of illness, the disease being discoverable only on a post-mortem examination. The question therefore as to whether the animals used were free from tuberculosis was decided, not by keeping the animals for some time before using them for experiment, but by the results of the post-mortem examination of the non-experimental animals that died, these acting as controls.

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* The microscopical work was done at the Laboratories of the Royal College of Physicians and of Surgeons, Victoria Embankment, W.C.

† In other investigations, I have always adopted the following plan for disinfecting rabbits' and guinea-pigs' cages: first a thorough scrubbing with soap and water, then immersing in boiling water, washing with 1 in 20 solution of carbolic acid, and finally, after drying, limewashing the inside of the cage.

7 Guinea-pigs were purchased in lots of two or three dozen, or of 50 or 100 as the occasion required; they came, some from the country, some from the dealers in London. They were all kept in a run in the guinea-pig house, and fed on the sterilized food. They were removed to the cages in twos or fours as required for experiment. During the course of the investigation large numbers of the animals died; some from a change in the weather, showing post-mortem signs of broncho-pneumonia, while others showed after death lesions of a parasitic disease which is described below under the heading of "Bacterial necrosis."

ontrol uinea-pigs: ause of eath.

8 Thus 203 non-experimental guinea-pigs died; they were all examined post-mortem.

Of these, 124* shows the signs of patchy consolidation and congestion of the lungs (broncho-pneumonia); seven died from septicæmia, due to parturition or other causes; nine showed white patches in the liver and spleen (described as bacterial necrosis, p. 21), and 63 showed no naked-eye signs of disease post-mortem. Every doubtful nodule in these animals was examined microscopically, but there was not a trace of tubercle in any of the animals. Although, therefore, the cause of death of these control animals was not always evident, yet they were all free from tubercle.

Large numbers of the experimental animals died with the same signs as the non-experimental; but in many the cause of death was not ascertainable. Attention was devoted chiefly to the presence of tuberculosis.

Experimental uinea-pigs: ause of eath.

9 The number of guinea-pigs used for experiment was as follows:—

Experiments with Meat: guinea-pigs inoculated, 53; fed, 135; total, 188.

Experiments with Milk: guinea-pigs inoculated, 93; fed, 113; total, 206.

The total number of guinea-pigs used was 394.

The following table shows the cause of death as far as could be ascertained:—

TABLE I.

Cause of Death.	Experiments with Meat.		Experiments with Milk.		Total.
	No. of Guinea-pigs inoculated.	No. of Guinea-pigs fed.	No. of Guinea-pigs inoculated.	No. of Guinea-pigs fed.	
Broncho-pneumonia	23	68	35	71	197
No evident cause of death.	5	37	21	25	88
Killed - -	12	22	19	4	57
Tuberculosis -	—	2	13	9	24
Septicæmia - -	5	1	1	1	8
Abscess - -	5	—	2	—	7
Peritonitis - -	2	1	1	—	4
Parturition - -	—	—	—	3	3
Bacterial necrosis -	1	2	—	—	3
Duodenal ulcer -	—	2	—	—	2
Hæmorrhage into Pericardium.	—	—	1	—	1
Total -	53	135	93	113	394

10 Slightly more than half of the experimental animals, therefore, died of inflammation of the lungs; in nearly one quarter no cause of death could be discovered by the naked eye. Of the inoculations with the meat, 10 animals died from the direct effects of the experiment, five from septicæmia, and five from a local abscess; three animals in the experiments with the milk died in a similar way. These 13 cases of abscess and septicæmia were the only avoidable causes of death; they form, however, but a small proportion of the total number (146) of inoculations performed. Every means was tried to prevent the guinea-pigs dying of broncho-pneumonia, but without avail. In three animals death was to be ascribed to parasitic disease, the lesions of which were extensive; but similar lesions, although less extensive, were found in 55 other animals, *i.e.*, in 52 of the animals that were fed, and in three of those inoculated. These lesions were of the same kind as those occurring in the non-experimental animals, and are considered on p. 21. Of the guinea-pigs inoculated with meat and milk, 146 in number, 20 died in the first week of experiment; the remaining lived long enough to enable a microscopical diagnosis of tubercle to be made, the majority of these animals living more than three weeks. Of the 248 guinea-pigs fed with meat or milk, 103 died within the first month, leaving 145 animals in which it was possible for a diagnosis of tubercle to be made (*see* p. 21, diagnosis of tuberculosis).

Rabbits.

11 *Rabbits.* Twenty-seven rabbits were used for experiment; eight others not used for experiment died. The cause of death in these latter was not ascertainable from a naked eye examination of the organs. They showed no signs of tuberculosis or of parasitic disease of the internal organs. Of the 27 experimental animals, 14 were inoculated with meat or milk, and 13 fed. Of the latter 12 were killed and one died of pneumonia; of those inoculated, 10 were killed, one died and showed no obvious cause of death post-mortem, one died from pneumonia, one from tuberculosis, and one from a local abscess following inoculation. Of the rabbits inoculated with meat or milk, 14 in number, one lived only one day, one lived 14 days, one 29 days, and one 38 days, while the remaining 10 were killed at varying periods from 56 days to 120 days. Of the rabbits fed with meat or milk, 13 in number, one died in 21 days, and the remainder were killed at periods varying from 55 days to 141 days.

12 The most important fact regarding guinea-pigs and rabbits from the point of view of this research is that, although very susceptible to the disease, they do not suffer from tuberculosis as a natural disease; they do not acquire it spontaneously. Cases have been recorded in which, *in a laboratory*, these rodents have been found on examination to be tuberculous without obvious source of infection, but such an occurrence can only result from a breach of the strict hygienic rules which are an absolute necessity in a laboratory for pathological research. In the experiments recorded in this report, 597 guinea-pigs were examined minutely post-mortem, and a microscopical examination made of doubtful lesions; in not one of the non-experimental animals, 203 in number, was a tuberculous lesion discovered, and tuberculosis was discovered in only those of the experimental guinea-pigs which had been inoculated or fed with tuberculous material. Again, of 35 rabbits examined post-mortem, eight control animals showed no tuberculous lesion, and only those experimental rabbits showed the disease which had been exposed to infection.

Rabbits and guinea-pigs, therefore, kept under ordinary hygienic conditions may be used as a very delicate test for the infectivity of tuberculous material.

Pigs.

13 With pigs the question is somewhat different. Although not very frequent in these animals, yet tuberculosis is a disease which does occur naturally in them. They are also foul feeders, and have ample opportunity of eating tuberculous material, when this is thrown away as offal. Means were taken to guard against the use for experiment of pigs which were tuberculous. Only young pigs were used, litters being purchased and kept apart, and one pig reserved as a control, the rest being used for experiment. When possible the litter was kept for some weeks before being used in order to see if any of the animals were ill, but at one time in the course of the research, pigs were very difficult to purchase, and when obtained had to be used at once, as material was ready for feeding and would not keep. The advantage of purchasing a litter, or part of a litter of pigs was, that if one of a litter developed tuberculosis apart from any infective material given to it, that particular litter could be discarded from consideration. If, on the other hand, young pigs had been purchased indiscriminately, *i.e.*, without regard to litters, no reliance whatever could be placed on the results of the investigation as regards pigs. In any case, pigs are not so reliable as rodents in such an investigation as that under consideration; but the results obtained from feeding them with the meat and milk of tuberculous animals have a direct bearing on the distribution of tuberculous lesions in certain cases occurring in human beings. One great advantage of using them for experiment was that a thorough test of the infectivity of the meat and milk could

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* In 12 of these there were the lesions of the organs, described on p. 21 as bacterial necrosis.

applied, since large quantities of these products could be given to them as food.

The following is a list of the pigs purchased, and used for experiment:—

14 TABLE II.

Showing Litters of Pigs used, Nature of Experiment, and Result.

Litter.	Age of Pigs.	Material used for Feeding.	Result of Post-Mortem.	Remarks.
Litter I. of 13 pigs	10 weeks	2 pigs: Meat, Cow No. 20	Both tuberculous	Remaining 11 pigs killed for swine fever; no tuberculosis.
Litter II. of 5 pigs	11 weeks	2 pigs: Meat, Cow No. 21 1 pig: Meat, Cow No. 6 1 pig: Milk, Cow No. 16 1 control pig	1 tuberculous: 1 Nil. Nil. Nil. Nil.	
Litter III. of 5 pigs	12 weeks	1 pig: Milk, Cow No. 22 1 pig: Milk, Cow No. 15 1 pig: Meat, Cow No. 15 1 pig: Meat, Cow No. 22 1 control pig	Nil. Nil. Nil. Nil. Nil.	
Litter IV. of 6 pigs	8 weeks	-	-	All killed for swine fever.
Litter V. of 2 pigs	15 weeks	1 pig: Milk, Cow No. 12 1 control pig	Nil. Nil.	
Litter VI. of 4 pigs	9 weeks	1 pig: Meat, Cow No. 12 1 pig: Milk, Cow No. 8 1 pig: Tuberculous lung, Cow No. 13 1 control pig	Nil. Tuberculosis. Tuberculosis. Nil.	
Litter VII. of 5 pigs	13 weeks	1 pig: Milk, Cow No. 26 1 pig: Skimmed milk, Cow No. 26 1 pig: Butter, Cow No. 26 1 pig: Milk, Cow No. 23 1 control pig	Nil. Advanced tuberculosis. Nil. Nil. Nil.	Tuberculous on arrival.
Litter VIII. of 6 pigs	10 weeks	1 pig: Skimmed milk, Cow No. 27 1 pig: Butter, Cow No. 27 1 pig: Meat, Cow No. 23 1 pig: Meat, Cow No. 23 1 pig: Milk, Cow No. 17 1 control pig	Nil. Tuberculosis Tuberculosis. Nil. Nil. Nil.	Tuberculous on arrival.

15 The experiments performed with the pigs of Litters I., II., III., V., and VI. hold good. None of the control pigs showed tuberculosis, and the cases of tuberculosis occurring corresponded to the results of the experiments on guinea-pigs. The meat of Cows No. 20 and 21 (used in Litters I. and II.) was also found infective to guinea-pigs, and the milk of Cow No. 8 (used in Litter VI.) was also found infective in rabbits. But in Litter VII. and VIII. two cases of tuberculosis occurred, one in each, not attributable to the material used for feeding. Thus one of the pigs of Litter VII. was fed with the skimmed milk of Cow No. 26, which was not tuberculous, and, as shown in numerous experiments, did not yield infective milk (*see* Part III., p. 40); yet the pig in question showed, on post-mortem examination, most advanced tuberculosis of the intestinal tract and internal organs. This Litter VII. was used for experiment soon after arrival at Harrow, and the pig in question had evidently, before arrival, eaten a large quantity of tuberculous material.

16 Similarly, one of the pigs of Litter VIII., fed with the butter of Cow No. 27, which was not tuberculous (*see* p. 40) showed tuberculosis of the lungs and lymphatic glands in the thorax. This litter was, like Litter VII., used for experiment directly on arrival at Harrow. The pig could not have got the disease from the butter as this was not infective; it had acquired the disease before arrival. The pig-styes were all kept in hygienic condition; the pigs had nothing but sterilized food (except during the experiment), therefore, the only conclusion regarding the two cases of tuberculosis in Litters VII. and VIII. is that the disease was acquired before arrival at Harrow. It is evident, however, that if one pig in a litter acquired the disease in this way, any other pig of the same litter which was found tuberculous on examination might have acquired the disease in the same way. It is best, therefore, to exclude such litters in considering the results of the experiments, in so far as regards any positive results obtained from feeding. Thus the pig in Litter VIII. which became tuberculous after being fed with the meat of Cow No. 23 must be excluded; although the kind and extent of tuberculosis found corresponded perfectly with the time that elapsed between the experiment and death.

All the negative experiments necessarily hold good.

17 Pigs are, from the facts brought forward, not such satisfactory animals as rodents to use for experiments with tuberculosis; but with the precautions taken, the results must be considered as accurate. All the facts must be taken together, not only the results of the post-mortem examination of the pigs of each litter, but the degree and locality of the tuberculosis resulting in a certain period between feeding and death.

Two of the experimental pigs died, one in 68 days from the commencement of the experiment, of a collection of *Strongylus filaria* in the bronchial tubes (Litter VI., Pig 2), the other in 68 days from acute tuberculosis (Litter VII., Pig 2). The remainder of the pigs were killed at periods varying from 8 weeks to 29 weeks after the commencement of the experiment:—

1 pig was killed in 8 weeks.
3 pigs were killed in 9 weeks.
3 ,, ,, 11–12 weeks.
7 ,, ,, 13–16 ,,
4 ,, ,, 19–22 ,,
2 ,, ,, 27–29 ,,

The control animals were killed in periods varying from 13 to 43 weeks; those of the first litter were, however, killed in 28 days on account of some of the litter developing swine-fever.

18 Ten calves in all were used for experiment; four of these being fed with tuberculous material from a cow; six being fed with the sputum from cases of pulmonary tuberculosis in man. Calves.

Eight calves arrived at Harrow on June 30th, 1891, aged about three months; four of these were kept 36 days before being used for experiment, and the remaining four 63 days before being used. In the time between arrival and being used for experiment they all improved in general nutrition.

Two calves arrived at Harrow, January 7th, 1893, one, a Jersey, aged nearly five months, the other, a cross-bred, aged nearly four months. They were kept 43 days before being used for experiment, and improved greatly in condition. Keeping the calves some time before use was the only precaution possible in determining whether they were tuberculous or not.

THE COURSE OF TUBERCULOSIS IN ANIMALS—GUINEA-PIGS, RABBITS, PIGS AND CALVES.

19 Abundant opportunity was afforded during the investigation of observing the course of tuberculosis both in inoculation and in feeding experiments. There is a great difference between the results of inoculation and feeding with tuberculous material. In inoculation subcutaneously and into the peritoneal cavity, the material is introduced directly into the tissues of the body, and the tubercle bacilli it contains grow without hindrance and produce tuberculosis. But when an animal is fed with tuberculous material, this enters a portion of the organism, which is practically outside the tissues of the body, and not only is this the case, but the infective material is exposed to the battery of the digestive juices (acid in the stomach, alkaline in the small intestine); to the defensive epithelium and leucocytes lining the alimentary tract; and to the peristalsis of the gut. It is small wonder, therefore, that a certain (undetermined) amount of tuberculous material is necessary in order to be infective by way of the intestine; or, in other words, that an animal may eat with its food a certain amount of tuberculous material, and yet not develop tuberculosis. Individual susceptibility has to be taken into account in considering the results obtained, but it is a factor very difficult to gauge. Although, for example, there appears no difference between individual guinea-pigs as regards susceptibility to the disease, and even as regards rabbits; yet it is possible that different breeds of pigs are susceptible to a varying degree, and it is certain that different breeds of calves vary, as will be seen, greatly in this respect. Difference in susceptibility in the human subject is, as is well-known, well marked between one person and another, and forms indeed the chief feature in so-called "inherited" tuberculosis.

20 The facts as to the course of tuberculosis may now be stated. Many of these facts are well-known, especially regarding the course of the disease following the inoculation or feeding with obvious tuberculous material—*i.e.*, with a tuberculous mass in which tubercle bacilli can be demonstrated. But, in many cases, the meat and milk of tuberculous cattle has been found infective (*see* Parts II. and III. of the Report) when it was found impossible to demonstrate after an exhaustive examination that the meat contained any tuberculous lesions, or that the milk contained tubercle bacilli. The difference in the results obtained from the inoculation of obvious tuberculous material, on the one hand, and of that which cannot be shown to be tuberculous, and yet is infective is instructive. These results are probably simply a question of dosage, of a large dose of the virus in the first case, of a small dose in the second.

(I.) *Subcutaneous Inoculation of Tuberculous Material in Guinea-pigs and Rabbits.*

urse of berculosis lowing oculation.

21 When a guinea-pig is inoculated beneath the skin of the groin with tuberculous material, a local lesion is first produced, and this is followed by an infection of the lymphatic glands of the body in a definite order. The glands of groin (inguinal) first become tuberculous, then the lumbar lymphatic glands, then the lymph glands around the stomach (cœliac and retro-hepatic) and the posterior mediastinal and bronchial lymphatic glands in the thorax; this extent of disease is followed at some length of time (or it may not be followed at all) by an infection of the anterior mediastinal lymph glands, of the cervical and the mesenteric glands. The liver and spleen become affected at about the same period as the posterior mediastinal bronchial glands, and infection of the lungs follows tuberculosis of the bronchial glands. The kidneys and suprarenal bodies and intestines are never affected. If the inoculation be made in one groin only, then the inguinal glands and the lumbar glands of that side alone are affected; but if the inoculation be made in both groins, then the inguinal glands and lumbar glands of both sides are affected.

In rabbits the course of tuberculosis following subcutaneous inoculation in the groin is the same as in the guinea-pig, except that if the animal lives long enough, the kidneys become affected. The following table demonstrates the facts which have just been stated (Table III., *see* p. 14):—

23 This table shows the very regular manner in which tuberculosis progresses in the guinea-pig after the inoculation of tuberculous material in the subcutaneous tissues of the groin.

It is to be noted that as early as nine days after inoculation a lesion is developed which may be diagnosed as tuberculous on microscopical examination; that in about the third week after inoculation the disease spreads to the internal lymphatic glands, always affecting the lumbar glands, and usually affecting the cœliac glands before it spreads to the liver and spleen; and that when it spreads to the organs of the thorax the cœliac glands are affected, then the posterior mediastinal and bronchial glands, and then the lungs. The lungs were not affected before the fifth week, and the mesenteric glands only in very advanced tuberculosis. The immunity of the supra-renal bodies and the kidneys to the disease is a point worthy of notice.

24 All the animals shown in the table were not inoculated with virulent tuberculous material; thus the milk of Cow No. 8 (Table III., experiments I., and IV.–VII.) was not virulent; it contained no demonstrable tubercle bacilli (*see* Part III., Report on the milk experiments), and the milk of Cow No. 24 (Table III., experiment II.) was also not virulent. Some of the results therefore do not quite bear out the remarks made at the commencement. Thus in experiments I., V., VI. in the table, although the animals were inoculated with the material in each groin, tuberculosis developed on only one side, showing that the virus was not evenly distributed in the milk (*see* Part VIII., p. 87). This is also shown in the experiments with the meat, but as this point is fully discussed in the Report on the meat experiments (Part II.), it need only be mentioned here. Experiments VIII., IX., X., XI., and XII. in the table were made with virulent tuberculous material, and from them can be deduced the facts mentioned above. The chief fact of import in these experiments on the meat or milk is that in five or six weeks after inoculation of guinea-pigs in the groin with obvious tuberculous material, all the internal lymphatic glands and organs, with the exception of the kidneys, supra-renal bodies, and the lymph glands in connexion with the intestinal tract (mesenteric or cæcal) become affected with tuberculosis.

25 The course of tuberculosis after inoculation in rabbits is the same as in guinea-pigs. One experiment may be quoted. A rabbit was inoculated in each groin subcutaneously with 5 cc. of milk (Cow No. 24). It died in 84 days, and showed tuberculosis of both inguinal and both lumbar glands, of the cœliac, posterior mediastinal and bronchial glands, the liver, spleen, lungs, heart, and kidneys.

It is to be noted that in all the cases where infective milk was inoculated, the disease spread if the animal lived sufficiently long; but the same was not the case with the inoculation with the meat. In some instances the inoculation of meat or meat juice produced only a "local tuberculosis," even though the animal lived over 60 days. This point is fully discussed in the Report on the meat experiments (p. 29). It is important as showing that even in a susceptible animal the disease may remain a local one, provided the dose be small enough.

2. *Intra-peritoneal Injection of Tuberculous Material.*

26 The development of tuberculosis following the injection of tuberculous material into the peritoneal cavity is more rapid than when the inoculation is subcutaneous. When the tuberculous material is virulent, it is remarkable with what rapidity the disease spreads from the peritoneum to the organs and glands of the body. As will be seen from the following Table (IV.) (*see* p. 15) the disease of the omentum and peritoneum generally is well marked in 14 days after inoculation. It can be readily recognised, not only by the naked eye appearances, but by a microscopical examination. A preparation made by rubbing a coverglass over the cut surface of the omentum shows numerous tubercle bacilli after staining in the usual manner.

3. *Feeding of Rodents, Pigs, and Calves with Tuberculous Material.*

Course of tuberculosis following feeding in guinea-pigs.

28 When obvious tuberculous material is given to guinea-pigs there is first produced a tuberculous lesion of the intestine, usually in the small intestine, sometimes in the cæcum and large intestine, sometimes in both small and large intestines. This is followed by tuberculosis of the lymphatic glands in connexion with the intestine, viz., the mesenteric or the cæcal glands. From these glands the disease spreads either to the cœliac glands (the glands around the stomach) or to the liver and spleen; or both cœliac glands and liver and spleen may become affected. The posterior mediastinal glands and bronchial glands then become diseased; and finally the lungs. In some cases the anterior mediastinal and the lumbar glands are then affected. The disease, therefore, runs a definite course.

To illustrate this the following experiments may be quoted:—

A. Four guinea-pigs were fed with 20 cc. of phthisical sputum containing a large number of tubercle bacilli. The sputum was mixed with the sterile food; being all

22 TABLE III.

Showing the Course of Tuberculosis following the Subcutaneous Inoculation of Tuberculous Material in Guinea-Pigs.

Material used for Inoculation.	No. of days the animals lived after Inoculation.	Parts affected with Tuberculosis.										
		Local Lesion.*	Inguinal Glands.		Lumbar Glands.		Cœliac Glands.	Posterior, Mediastinal, and Bronchial Glands.	Liver.	Spleen.	Lungs.	Other Organs affected.
			Right.	Left.	Right.	Left.						
I. Milk : Cow No. 8 1 cc. : each groin.	9 days	- - -	**Tubercle** T.B. x.	Nil.	Nil.	Nil.	Nil.	Nil.	Nil.	Nil.	Nil.	Nil.
II. Milk : Cow No. 24 2 cc. : right groin.	18 days	**Tubercle** T.B.xx. Right side.	Nil.	Nil.	Nil.	Nil.	Nil.	Nil.	Nil.	Nil.	Nil.	Nil.
III. Milk : Cow No. 8 1 cc. : each groin.	25 days	- - -	**Tubercle** T.B. xx.	**Tubercle** T.B. xx.	**Tubercle**	**Tubercle**	**Tubercle**	**Tubercle**	**Tubercle**	**Tubercle**	Nil.	Nil.
IV. Milk : Cow No. 8 1 cc. : each groin.	26 days	- - -	**Tubercle** T.B. xx.	**Tubercle** T.B. xx.	**Tubercle**	**Tubercle**	Nil.	Nil.	Nil.	**Tubercle**	Nil.	Nil.
V. Milk : Cow No. 8 1 cc. : each groin.	31 days	- - -	**Tubercle** T.B. xx.	Nil.	**Tubercle**	Nil.	Nil.	Nil.	**Tubercle**	**Tubercle**	Nil.	Nil.
VI. Milk : Cow No. 8 1 cc. : each groin.	31 days	- - -	**Tubercle** T.B. x.	Nil.	**Tubercle**	Nil.	**Tubercle**	**Tubercle**	**Tubercle**	**Tubercle**	Nil.	Nil.
VII. Milk : Cow No. 8 1 cc. : each groin.	34 days	- - -	**Tubercle** T.B. xx.	**Tubercle** T.B. xx.	**Tubercle**	**Tubercle**	**Tubercle**	**Tubercle**	**Tubercle**	**Tubercle**	Nil.	Nil.
VIII. Milk : Cow No. 21 1 cc. : each groin.	36 days	- - -	**Tubercle** T.B. xx.	**Tubercle** T.B. xx.	**Tubercle**	**Tubercle**	**Tubercle**	**Tubercle**	**Tubercle**	**Tubercle**	**Tubercle**	Nil.
IX. Milk : Cow No. 25 1 cc. : right groin.	39 days	- - -	**Tubercle** T.B. x.	Nil.	**Tubercle**	Nil.	**Tubercle**	**Tubercle**	**Tubercle**	**Tubercle**	**Tubercle**	Nil.
X. Milk : Cow No. 21 0·3 cc. : right groin.	63 days	- - -	**Tubercle**	Nil.	**Tubercle**	Nil.	**Tubercle**	**Tubercle**	**Tubercle**	**Tubercle**	**Tubercle**	Cervical glands : anterior mediastinal : mesenteric glands (T.B. xxx).
XI. Caseous gland of a tuberculous guinea-pig : both groins.	62 days	- - -	**Tubercle**	**Tubercle**	**Tubercle**	**Tubercle**	**Tubercle**	**Tubercle**	**Tubercle**	**Tubercle**	**Tubercle**	Nil.
XII. Caseous gland from a pig (Pig 2, fed with meat of Cow 20).	92 days	- - -	**Tubercle**	**Tubercle**	**Tubercle**	**Tubercle**	**Tubercle**	**Tubercle**	**Tubercle**	**Tubercle**	**Tubercle**	Anterior cervical glands.

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* In most of the cases the local lesion was indistinguishable from the tuberculous inguinal glands. In the second case in the table there was a distinct tuberculous lesion, but no extension of the disease to the inguinal glands. The signs T.B. x, T.B. xx, T.B. xxx, used in this and the following tables, indicates a microscopical examination of the lesion and the relative number of tubercle bacilli found in the microscopical sections.

27 TABLE IV.

SHOWING THE COURSE OF THE TUBERCULOSIS FOLLOWING THE INTRA-PERITONEAL INOCULATION OF TUBERCULOUS MATERIAL IN GUINEA-PIGS.

Material used for Inoculation.	Duration of Experiment.	Lumbar Glands.	Cœliac Glands.	Anterior Mediastinal Glands.	Posterior Mediastinal Glands.	Bronchial Glands.	Cervical Glands.	Sub-mental Glands.	Omentum.	Peritoneum.	Liver.	Lungs.	Spleen.	Other Organs and Glands.
Milk: Cow 20: 2 cc.	14 days	Nil.	Nil.	Nil.	Nil.	Nil.	Nil.	Nil.	**Tubercle** T.B. x.	**Miliary Tubercle**	Nil.	Nil.	Nil.	Nil.
Milk: Cow 25: 1 cc.	14 days	**Tubercle**	**Tubercle**	**Tubercle**	Nil.	Nil.	Nil.	Nil.	**Tubercle** T.B. xx.	**Miliary Tubercle**	**Tubercle**	Nil.	**Tubercle**	Nil.
Milk: Cow 25: 1 cc.	14 days	**Tubercle**	**Tubercle**	**Tubercle**	**Tubercle**	Nil.	**Tubercle**	Nil.	**Tubercle** T.B. xx.	**Miliary Tubercle**	**Tubercle**	**Tubercle**	**Tubercle**	**Tuberculous** needle-track.
Milk: Cow 25: 1 cc.	16 days	**Tubercle**	**Tubercle**	**Tubercle**	**Tubercle**	**Tubercle**	**Tubercle**	Nil.	**Tubercle** T.B. xx.	**Miliary Tubercle**	**Tubercle**	Nil.	**Tubercle**	**Tuberculous** needle-track.
Milk: Cow 25: 1 cc. of a 10 per cent. dilution.	16 days	Nil.	Nil.	Nil.	Nil.	Nil.	Nil.	Nil.	**Tubercle** T.B. xx.	**Miliary Tubercle** (slight)	Nil.	Nil.	**Tubercle**	Mesenteric glands showed **Tubercle**.
Milk: Cow 20: 0·5 cc. diluted to 2 cc.	18 days	Nil.	Nil.	Nil.	Nil.	Nil.	Nil.	Nil.	**Tubercle** T.B. xx.	**Miliary Tubercle**	**Tubercle**	Nil.	**Tubercle**	Nil.
Milk: Cow 25: 1 cc. of a 10 per cent. dilution.	18 days	Nil.	**Tubercle**	**Tubercle**	Nil.	Nil.	Nil.	Nil.	**Tubercle** T.B. xx.	Nil.	**Tubercle** (commencing)	Nil.	**Tubercle**	Nodule of **Tubercle** at the seat of inoculation.
Milk: Cow 25: 1 cc. of a 5 per cent. dilution.	18 days	Nil.	**Tubercle**	**Tubercle**	Nil.	Nil.	Nil.	Nil.	**Tubercle** T.B. xx.	**Miliary Tubercle** (localized)	Nil.	Nil.	**Tubercle**	**Tuberculous** needle-track.
Milk: Cow 25: 1 cc.	19 days	**Tubercle**	**Tubercle**	**Tubercle**	Nil.	Nil.	Nil.	Nil.	**Tubercle** T.B. xx.	**Miliary Tubercle**	**Tubercle**	Nil.	**Tubercle**	**Tubercle** of mesenteric and retro-hepatic glands. Nodules of **Tubercle** in the capsule of left kidney.
Milk: Cow 25: 1 cc. of a 5 per cent. dilution.	20 days	Nil.	**Tubercle**	**Tubercle**	Nil.	Nil.	Nil.	Nil.	**Tubercle** T.B. x.	Nil.	**Tubercle**	Nil.	**Tubercle**	Nil.
Milk: Cow 25: 1 cc.	23 days	**Tubercle**	**Tubercle**	**Tubercle**	**Tubercle**	**Tubercle**	**Tubercle**	Nil.	**Tubercle** T.B. xx.	**Miliary Tubercle**	**Tubercle**	Nil.	**Tubercle**	Nil.
Cow 25: 1 cc. butter.	27 days	**Tubercle**	**Tubercle**	**Tubercle**	**Tubercle**	Nil.	Nil.	Nil.	**Tubercle** T.B. xx.	**Miliary Tubercle**	**Tubercle**	Nil.	**Tubercle**	**Tubercle** at seat of inoculation and of mesenteric glands.
Cow 25: 1 cc. butter milk.	27 days	**Tubercle**	**Tubercle**	**Tubercle**	**Tubercle**	**Tubercle**	Nil.	**Tubercle**	**Tubercle** T.B. xx.	**Miliary Tubercle**	**Tubercle**	**Miliary Tubercle**	**Tubercle**	**Tubercle** of needle-track, and of mesenteric, inguinal, and retro-hepatic glands.
Cow 25: 1 cc. skimmed milk.	29 days	**Tubercle**	**Tubercle**	**Tubercle**	**Tubercle**	**Tubercle**	Nil.	Nil.	**Tubercle** T.B. xx.	**Miliary Tubercle**	**Tubercle**	Nil.	**Tubercle**	**Tubercle** of needle-track, and of mesenteric, inguinal, and retro-hepatic glands.

added to the food in one day. One guinea-pig was killed in 14 days after feeding; the second in 28 days; the third in 42 days; and the fourth died in 53 days. The first guinea pig (killed in 14 days) showed no signs of tubercle in the intestines or elsewhere; an exhaustive microscopical examination being made (*see* Part IX.). The remaining three animals showed tuberculosis as in the following table:—

29 TABLE V.

Tuberculosis in Guinea-Pigs, following a Single Feeding with Phthisical Sputum.

Duration of Experiment.	Parts affected with Tuberculosis.									
	Intestine.		Mesenteric Glands.	Cæcal Glands.	Cœliac Glands.	Liver.	Spleen.	Posterior Mediastinal, and Bronchial Glands.	Lungs.	Other Organs.
	Small.	Cæcum.								
28 days	**Tubercle**	**Tubercle**	**Tubercle** T.B. x.	Nil	Nil	Nil	Nil	Nil	Nil	Nil
42 days	**Tubercle**	Nil	**Tubercle** T.B. x.	**Tubercle**	Nil	**Tubercle**	**Tubercle**	Nil	Nil	Nil
53 days	Nil	**Tubercle**	Nil	**Tubercle**	Nil	**Tubercle** T.B. x.	**Tubercle** T.B. x.	**Tubercle** T.B. x.	**Tubercle** T. B. x.	Nil

B. The foregoing experiment may be compared with the following, in which four guinea-pigs received at a single feeding a small quantity of the tubercular udder of a cow ground up with a little water—the whole measuring about one ounce. One guinea-pig died in 12 days; the second was killed in 59 days; the third died in 78 days; the fourth in 92 days. The first animal showed no tuberculosis; the remaining three showed the disease in an advanced stage, as in the following table:—

30 TABLE VI.

Tuberculosis in Guinea-Pigs, following a Single Feeding with Bovine Tuberculous Material.

Duration of Experiment.	Parts affected with Tuberculosis.									
	Intestine.		Mesenteric Glands.	Cæcal Glands.	Cœliac Glands.	Liver.	Spleen.	Posterior, Mediastinal, and Bronchial Glands.	Lungs.	Other Organs.
	Small.	Cæcum.								
59 days	**Tubercle**	**Tubercle**	**Tubercle**	**Tubercle**	**Tubercle** T.B. x.	**Tubercle**	**Tubercle**	**Tubercle**	**Tubercle**	Nil
78 days	**Tubercle** T.B. x	**Tubercle**	**Tubercle**	**Tubercle**	**Tubercle**	**Tubercle**	**Tubercle**	Nil	Nil	Nil
92 days	**Tubercle**	**Tubercle**	**Tubercle**	**Tubercle**	**Tubercle**	**Tubercle**	**Tubercle**	**Tubercle**	**Tubercle**	Nil

These two experiments show that a single feeding of tuberculous material, either from the human being or the cow, gave tuberculosis to all the animals that lived 28 days; that in the first 14 days of the experiment no sign of the disease was evident in the intestines or elsewhere; that the disease commenced by an affection of the intestines, and spread to the mesenteric glands in about four weeks after the commencement of the experiment.

In the cases of tuberculosis resulting from feeding with the meat or milk of tuberculous cows, repeated doses of the infective material were given. The results are shown in the following table (Table VII.), and confirm those obtained by a single feeding with virulent tuberculous material. The approximate amount of meat or milk eaten by each anaimal is given, and full details of the experiments will be found in Parts VII. and VIII. of the Report.

32 From this table it is seen that the earliest period after feeding at which tuberculosis was detected in the experimental guinea-pig was 18 days, the lesion being just visible to the naked eye but showing the structure of tubercle with numerous tubercle bacilli when examined microscopically. After the third week, the mesenteric glands became affected. After the fifth week, the liver and spleen, and in some cases the cœliac glands became tuberculous; at subsequent periods, however, the further distribution of the disease is somewhat irregular.

33 Three instances occurred in which the tuberculosis did not spread, and are not included in the preceding table. These all occurred in the same experiment. Thus four guinea-pigs were fed in two days with 200 cc. of the milk of Cow 21: *i.e.*, each animal got about 50 cc. of milk. One guinea-pig in 25 days showed no tuberculosis, the second died in 49 days, the third in 53 days, and the fourth in 67 days. These last three developed tuberculosis, but the disease was present only in the intestines and mesenteric glands in the first two of them, and only in the mesenteric glands in the third. In 49 days, as shown by the table, the disease has usually extended to the liver and spleen. The explanation why it did not do so in the experiment rests on the fact that the milk was not so virulent as that of Cows 20 and 25: tubercle bacilli were present in the milk of only one quarter of the udder (*see* Milk Report, Part III.) The animals, therefore, received a smaller dose of the poison, and the disease affected only the intestines and mesenteric glands in two animals, and the mesenteric glands only in one. This last is the only instance in the guinea-pig in which the intestine was not affected, although the mesenteric glands became tuberculous, and it is interesting not only from its actual occurrence (showing that the tubercle bacilli could pass through the intestine to the mesenteric glands without producing a local lesion), but also from the fact that it occurred when a small dose was given.

If the tuberculous material is still less virulent, as it was in Cow No. 8, in 32 days only a small local lesion may be produced in the intestine (*see* Part VIII., p. 88).

From these facts it was considered that in feeding guinea-pigs with the meat and milk of tuberculous cows, no negative result could be taken into consideration unless the animal had lived at least 28 days after commencement of the experiment.

Rabbits.

34 In rabbits the tuberculosis resulting from feeding appears slower in developing than in guinea-pigs. Thus one rabbit fed with 600 cc. of virulent milk from Cow No. 25 showed in 57 days only tuberculosis of the small intestine and of the mesenteric glands. Another rabbit fed with 500 cc. of the skimmed milk of the same cow, diluted with an equal part of skimmed milk from a healthy cow, showed in 79 days tuberculosis of the small intestine and cæcum, of the mesenteric glands, and of the posterior mediastinal and bronchial glands and lungs. In this case, the disease had, so to speak, skipped the abdominal organs, except those mentioned, and passed to those in the thorax.

A few of the rabbits died before 50 days, but the great majority were killed after this period, so that these could be considered as tests of infectivity. The two rabbits mentioned above were the only two in which tuberculosis developed, so that there is no experiment to show the earliest state at which tuberculosis appears in these animals after feeding. One rabbit, however, fed with the infective butter of Cow No. 25, died in 21 days without any sign of tuberculosis (p. 94, Part VIII.): so, as far as it goes, this experiment shows that in three weeks after feeding there is no visible sign of tubercle developed in the intestines of rabbits.

Pigs.

35 The course of tuberculosis in pigs from feeding is widely different from that in rabbits and guinea-pigs. In these rodents, it was only a question of affection of the small intestine, and the cæcum and large intestines, together with the lymphatic glands in connexion with them; the mesenteric and cæcal. In the pig other lymph glands may be primarily affected; those below the jaw (sub-

31 TABLE VII.

TUBERCULOSIS IN GUINEA-PIGS, FOLLOWING REPEATED FEEDING WITH TUBERCULOUS MILK AND MEAT.

Material used for Feeding.	Duration of Experiment.	PARTS AFFECTED WITH TUBERCULOSIS.												
		Intestines.		Mesenteric Glands.	Cæcal Glands.	Cœliac Glands.	Liver.	Spleen.	Bronchial and Posterior Mediastinal Glands.	Lungs.	Anterior Mediastinal Glands.	Glands in Lesser Omentum.	Lumbar Glands.	Other Organs.
		Small.	Cæcum.											
Milk : Cow 20 : 152 cc.	18 days	**Tubercle** T.B. xxx.	**Tubercle** (in Colon.)	Nil.	Nil.	Nil.	Nil.	Nil.	Nil.	Nil.	Nil.	Nil.	Nil.	Nil.
Milk : Cow 20 : 52 cc., diluted 4 times.	19 days	**Tubercle** T.B. xxx.	Nil.	Nil.	Nil.	Nil.	Nil.	Nil.	Nil.	Nil.	Nil.	Nil.	Nil.	Nil.
Milk : Cow 20 : 152 cc.	20 days	**Tubercle** T.B. xxx.	**Tubercle**	Nil.	Nil.	Nil.	Nil.	Nil.	Nil.	Nil.	Nil.	Nil.	Nil.	Nil.
Milk : Cow 20 : 152 cc.	20 days	**Tubercle** T.B xxx.	**Tubercle**	Nil.	Nil.	Nil.	Nil.	Nil.	Nil.	Nil.	Nil.	Nil.	Nil.	Nil.
Meat : Cow 21 : 143 g.	32 days	**Tubercle**	Nil.	**Tubercle** T.B. xx.	Nil.	Nil.	Nil.	Nil.	Nil.	Nil.	Nil.	Nil.	Nil.	Nil.
Meat : Cow 25 : 125 cc.	35 days	**Tubercle**	**Tubercle**	**Tubercle** T.B. xx.	**Tubercle**	**Tubercle**	**Tubercle**	**Tubercle**	Nil.	Nil.	Nil.	Nil.	Nil.	Nil.
Milk : Cow 20 : 52 cc., diluted 4 times.	37 days	**Tubercle**	**Tubercle**	**Tubercle**	**Tubercle**	Nil.	**Tubercle**	**Tubercle**	**Tubercle** T.B. xxx.	**Tubercle**	Nil.	Nil.	Nil.	Nil.
Milk : Cow 20 : 152 cc.	38 days	**Tubercle** T. B. xx.	**Tubercle**	**Tubercle**	**Tubercle**	Nil.	**Tubercle**	**Tubercle**	**Tubercle**	**Tubercle**	Nil.	Nil.	Nil.	Nil.
Meat : Cow 20 : 227 cc.	39 days	**Tubercle**	**Tubercle**	**Tubercle** T.B. x.	**Tubercle**	Nil.	**Tubercle**	**Tubercle**	Nil.	Nil.	Nil.	Nil.	Nil.	Nil.
Milk : Cow 25 : 125 cc.	45 days	**Tubercle**	**Tubercle**	**Tubercle** T.B. xx.	**Tubercle**	Nil.	**Tubercle**	**Tubercle**	Nil.	Nil.	**Tubercle**	Nil.	Nil.	Nil.
Milk : Cow 25 : 125 cc.	46 days	**Tubercle**	**Tubercle**	**Tubercle** T.B. xx.	**Tubercle**	**Tubercle**	**Tubercle**	**Tubercle**	Nil.	Nil.	**Tubercle**	Nil.	Nil.	Nil.
Milk : Cow 20 : 52 cc., diluted 4 times.	50 days	**Tubercle**	**Tubercle**	**Tubercle**	**Tubercle**	**Tubercle**	**Tubercle**	**Tubercle**	**Tubercle**	**Tubercle** T.B. xx.	Nil.	Nil.	Nil.	Nil.
Milk : Cow 25 : 75 cc.	59 days	**Tubercle**	**Tubercle**	**Tubercle**	**Tubercle**	**Tubercle**	**Tubercle**	**Tubercle**	**Tubercle**	**Tubercle**	Nil.	**Tubercle**	**Tubercle** T.B. x.	Nil.
Meat : Cow 20 : 227 g.	83 days	**Tubercle**	**Tubercle**	**Tubercle** T.B. x.	**Tubercle**	**Tubercle**	**Tubercle**	**Tubercle**	**Tubercle**	**Tubercle**	Nil.	Nil.	Nil.	Nil.

maxillary) which are in connexion with the mucus membrane of the mouth and the tonsil, those in the posterior mediastinum which are in connexion with the œsophagus, those in the upper part of the abdomen, the cœliac in connexion with the stomach, and those in the lesser omentum in connexion with the liver, the latter joining the cœliac.

36 As a type of advanced tuberculosis from feeding in the pig, the animal which had evidently eaten a large quantity of tuberculous material before arrival at Harrow, may be quoted (*see* p. 12). 1. There was a large tuberculous ulcer of the right tonsil, the corresponding lymphatic glands showing advanced tuberculosis which had spread to the chain of cervical glands. 2. There were numerous tuberculous ulcers in the cæcum, and the mesenteric glands were all affected. 3. The glands in the lesser omentum, the cœliac glands, and the posterior mediastinal were also affected. 4. There was tuberculosis also of the bronchial glands, of the liver, spleen, and lungs.* In this case infection had occurred at two points in the alimentary tract; at the right tonsil, and in the cæcum, the characteristic ulceration being produced.

37 The mode of infection in the pig was considered of such importance that a feeding experiment was performed with bovine tuberculous material. One of the pigs of Litter VI., nine weeks old, was fed once with 120 grammes of tuberculous lung from Cow 13. It was killed in 57 days after the first feeding. A small tubercular ulcer was present in one of the Peyer's patches in the middle of the ileum; otherwise the alimentary tract was normal. The mesenteric glands were tuberculous, also the posterior mediastinal and the glands in the lesser omentum, the liver, spleen, and lungs being markedly affected with miliary tuberculosis. In this case the mode of infection was by means of the small intestine and the mesenteric glands, and not by the cæcum or by the tonsil. It is to be noted too, that the intestinal lesion, a single small ulcer, was out of all proportion to the tuberculosis present in the organs of the body.

38 In the tuberculosis resulting from feeding pigs with the meat and milk of tuberculous cows, the absence of any lesion in the alimentary tract is very noticeable, so that the disease is first shown in its course from the alimentary tract by an affection of the lymph glands in connexion with the different parts of that tract. This is shown in the following table VIII. :—

39 TABLE VIII.

SHOWING THE COURSE OF TUBERCULOSIS IN PIGS FROM FEEDING WITH MEAT AND MILK. ALL ORGANS AND GLANDS NOT MENTIONED WERE NORMAL.

Material used for Feeding.	Duration of Experiment.	PARTS AFFECTED WITH TUBERCULOSIS.													
		Small Intestines.	Mesenteric Glands.	Large Intestines.	Colic Glands.	Tonsil and Pharynx.	Glands below the Jaw.	Glands in lesser Omentum.	Cœliac Glands.	Liver.	Spleen.	Posterior Mediastinal Glands.	Bronchial Glands.	Lungs.	Epididymis.
Milk of Cow 8, 12,060 cc.	68 days	Nil.	**Tubercle** T.B. x.	Nil.	Nil.	Nil.	Nil.	Nil.	Nil.	Nil.	Nil.	Nil.	Nil.	Nil.	Nil.
Meat of Cow 23, 4,645 g.	67 days	Nil.	Nil.	Nil.	Nil.	Nil.	**Tubercle** Rt. side T.B. x.	Nil.	Nil.	Nil.	Nil.	Nil.	Nil.	**Tubercle**	Nil.
Meat of Cow 21, 4,050 g.	106 days	Nil.	Nil.	Nil.	Nil.	Nil.	**Tubercle** Rt. side T.B. x.	Nil.	**Tubercle** T.B. x.	**Tubercle**	**Tubercle**	Nil.	Nil.	Nil.	Nil.
Meat of Cow 20, 1,190 g.	203 days	Nil.	Nil.	Nil.	Nil.	Nil.	Nil.	**Tubercle**	**Tubercle** T.B. x.	Nil.	Nil.	**Tubercle**	**Tubercle**	Nil.	**Tubercle**

40 From this table it is seen that no part of the alimentary tract became affected with tuberculosis, but it is also clear that in the first animal in the table, the infection occurred through the small intestines, since the mesenteric glands were affected; in the second animal, the infection took place solely through the right tonsil or right side of the pharynx, since the lymphatic gland below the jaw on that side was affected, and no other lymph gland in connexion with the alimentary tract. In the third animal the same mode of infection occurred, but also through the stomach or the duodenum into the cœliac glands. In the fourth animal, this latter mode of infection also occurred. It is impossible to say whether in this animal the posterior mediastinal glands were affected through the œsophagus or from the cœliac glands; both might obviously occur.

The chief points to be noted in these results as they bear on tuberculosis in the human being, is that by feeding with tuberculous material there may be no lesion in the alimentary tract; that there may be absorption only through the pharynx and tonsil producing tuberculosis of of the connected lymph gland, so that this condition of things exactly tallies with the "strumous" glands of children and young adults. Lastly, from feeding, there may be affection of the lymphatic glands alone, as in the fourth animal, and of an organ as widely separated from the seat of infection as the epididymis of the testicle.

The course of tuberculosis in calves from feeding was tested in 10 animals, four of which were fed with a moderate amount of tuberculous material from a cow, and six with sputum from cases of pulmonary tuberculosis in man.

A.—*Feeding of Calves with Bovine Tubercular Material.*
(Table IX.) (*See* p. 20.)

41 Four calves received at one meal mixed with their food about 1 kilogramme of tuberculous material from Cow 20, a case of advanced and generalised tuberculosis. One calf killed in four weeks showed numerous minute tuberculous nodules mostly in the Peyer's patches of the small intestines, tubercle bacilli being found in small quantities, the mesenteric glands, the bronchial glands, and the lungs being slightly affected.* The second calf, killed in a little over eight weeks, showed nine nodules of tubercle in the small intestine, and disease of the mesenteric, posterior mediastinal, bronchial, and cervical glands and of the lungs. The third calf killed in about 12 weeks, showed tubercular ulceration of the small intestine and the cæcum, and disease of the mesenteric, cæcal, posterior mediastinal, bronchial, and cervical glands, and of the lungs and pleura. The fourth calf, killed in 37 weeks, showed 25 nodules of tubercle in the small intestine, and disease of the mesenteric, posterior mediastinal, bronchial, retro-hepatic, and sub-maxillary lymphatic glands, as well as of the pleura. In calves 2 and 4, the nodules in the small intestine were considered tuberculous, although no tubercle bacilli were found, because they are absent in the intestines of healthy calves, and they were precisely similar both to the naked eye and to microscopical examination, to the nodules found in Calf 1, in which tubercle bacilli were found.

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* For the complete post-mortem examination, *see* Part VIII., p. 97.

1. It is important, therefore, to note that although from feeding calves with bovine tuberculous material, a local lesion in the form of nodules is produced in the intestine, it may not proceed to ulceration (as in Calf 3), but remain stationary as in Calves 2 and 4. The intestine is affected in the form of isolated nodules as early as four weeks after feeding (Calf 1). These nodules of tubercle, often caseous and calcareous, were also met with in tuberculous cows, in which the mesenteric glands showed advanced tuberculosis (*see* Part V., Cows 8, 16, 17, 18, and 23).
2. The mesenteric glands are in all cases affected to a greater or less extent.
3. From the intestinal lesion, the disease in calves spreads to the lymphatic glands in the thorax and the lungs or pleura or both of these.
4. It is interesting to note, in passing, that, from feeding, an affection of the pleura may ensue without the lungs becoming involved, as occurred in Calf 4.

B.—*Feeding of Calves with Human Tuberculous Material.*

42 *Experiment I.*—Four calves received at one meal mixed with their food 70 cc. of sputum (containing a large number of tubercle bacilli), from two cases of pulmonary tuberculosis in man. One calf killed in about four weeks showed 53 nodules of tubercle, mostly in the Peyer's patches of the small intestines; the second calf, killed in about eight weeks, showed 63 nodules similar to those found in the first calf; the third calf, killed in about 12 weeks, showed 13 nodules; and the fourth calf, killed in about 33 weeks, showed no nodules at all. In none of the calves was there any sign of disease, except in the intestines, and in Calf 4 every organ and gland was healthy. In Calf 3 the nodules in the intestine were proved to be tuberculous by the finding of tubercle bacilli. These were absent in the microscopical specimens made of the nodules in calves 1 and 2. Taking all the facts together, it must be concluded as in the case of Calves 2 and 4 fed with bovine tuberculous material, that these nodules were tuberculous, although no tubercle bacilli were found.

43 A dose of 70 cc. of sputum divided between four calves does not, therefore, produce the spreading disease observed in the experiment of feeding the calves with 1 kilogramme of bovine tuberculous material. It is impossible to determine whether 70 cc. of sputum is equal in infective virulence to 1 kilogramme of bovine tuberculous material. The sputum from cases of pulmonary tuberculosis in man has been considered to contain dead tubercle bacilli; but there is no doubt that it is infective material, and not only so, but that it is the infective material which is responsible for the production of many cases of the disease in human beings. It was considered desirable, therefore, to use a larger dose than 70 cc. for feeding.

44 *Experiment II.*—Two calves received at one feeding 440 cc. of sputum containing a large number of tubercle bacilli. One calf killed in eight weeks showed 13 tuberculous nodules in the small intestine, and tuberculosis of the mesenteric glands, tubercle bacilli being found in both sets of lesions; no other organ or gland in the body was diseased. The second calf, killed in about 19 weeks, showed no disease of any organ or gland in the body. This experiment, therefore, in which a larger dose was given, shows that sputum is not so infective to calves as bovine tuberculous material, since not only did one calf not take the disease, but the other calf in eight weeks showed only a local lesion of the intestines and of the mesenteric glands, while in eight weeks after feeding with bovine tuberculous material, the disease had spread from the intestines and mesenteric glands to the lymphatic glands of the thorax and to the lungs. The calf that developed tuberculosis was a Jersey; the other, a cross-bred.

It is evident, therefore, that in the case of tuberculous sputum we are dealing with material which is less infective to calves than bovine tuberculous material. This lessened infectivity is possibly not merely a question of dosage but one of diminished activity of the tubercle bacilli in sputum as compared to its activity in the tuberculous lesion of the cow.

The Pathological Diagnosis of Tuberculosis, and of other forms of Bacterial Necrosis.

46 The decision as to whether an animal is tuberculous or not is, as a rule, readily made by the naked eye alone, and rests not only on the changes which the tubercular lesion undergoes, but on the course of the disease through the lymph glands and organs of the body.

Naked eye appearance of tuberculous lesions.

In whatever animal tuberculosis develops, whether rodent, pig, calf, or man, the first evidence of the disease is shown in an aggregation of small whitish nodules which coalesce, and after growing become caseous; the caseous contents in some cases, as when tuberculosis affects the mucous membranes or when it affects the lungs in man being finally discharged, leaving a tuberculous ulcer or cavity. The caseation or fatty degeneration of the tuberculous nodule is the commencement of the retrograde stage of the lesion. In rodents (guinea-pigs and rabbits) the disease appears never to progress beyond this stage; but, in pigs, cows, and human beings the caseous tubercle frequently becomes calcareous, most frequently, perhaps, in the cow, and may finally degenerate completely, no longer retaining any infective material. This calcification of the tubercle occurs in long-standing cases; the earliest period in a pig in which the tuberculous glands became calcareous after feeding, was 106 days or 15 weeks (Pig A, Cow 21, meat-feeding p. 78, Part VII.) This caseo-calcareous tubercle is, however, still infective (*see* Pig B, Cow 20, meat-feeding p. 77, Part VII.) The calcification of the tuberculous lesion is not observed in rabbits and guinea-pigs, even when a local tuberculosis of long standing is present, as in some of the inoculation experiments with meat (*see* Part II.) Some of these animals lived 120 days after inoculation, and the local tuberculosis showed no calcification. In only one instance could a tuberculous lesion in a guinea-pig be said to show a retrograde state, and this consisted in deep pigmentation of the tuberculous lesions. This occurred in a feeding experiment with bovine tuberculous material (p. 100, Guinea-pig C.). This pigmentation occurs constantly in tuberculous lesions in the human being.

Course of tuberculosis.

47 In *Rodents*, for the purpose of diagnosis, the course of tuberculosis is of great importance. After a certain period there is no other disease which could be mistaken for it. Following inoculation in the groin, there is, as has been shown, a gradual progress of the disease from the inguinal lymph glands to the lumbar glands and the other glands and organs of the body. Following feeding, the disease begins in the intestines, and, after affecting the lymph glands in connexion with the gut, spreads to the other lymph glands and the organs of the body in a more or less definite order. Only one animal (a guinea-pig) proved an exception to this rule, and in it no lesion was found in the intestine. This instance has already been discussed (p. 16), and has been shown to be probably due to the small dose of tuberculous material given. Other bacterial infections besides tuberculosis occur through the intestine in the guinea-pig, but the course of the disease or diseases in this case is quite different from that of tuberculosis, chiefly from the irregularity of its distribution; in a few instances there being a lesion in the intestines or lymph glands attached, but in most the liver and spleen being chiefly affected. There is no natural disease in the guinea-pig which simulates tuberculosis in its progress and distribution.

As regards the higher animals used in the research, viz., *pigs* and *calves*, it has been seen that in pigs, the course of the disease after feeding with meat or milk is very irregular but all cases showed one common feature, viz., tuberculosis of one or other groups of lymph glands in connexion with the alimentary tract. From these glands the disease

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* For the complete record of the post-mortem examination of all the calves, *see* Part IX.

45 TABLE IX.

SHOWING THE COURSE OF TUBERCULOSIS IN CALVES FOLLOWING FEEDING WITH TUBERCULOUS MATERIAL (HUMAN and BOVINE).

Material used for Feeding.	Duration of Experiment.	PARTS AFFECTED WITH TUBERCULOSIS.									
		Small Intestine.	Mesenteric Glands.	Cæcum.	Cæcal Glands.	Posterior Mediastinal Glands.	Bronchial Glands.	Lungs.	Pleura.	Cervical Glands.	Other Glands or Organs.
Bovine. Four calves at one feeding received from one trough: 1 kilogram of tuberculous udder, lung, and gland from Cow 20.	28 days.	116 nodules of **Tubercle** T.B. x.	**Tubercle** T.B. xxx.	Nil.	Nil.	Nil.	**Tubercle** T.B. xxx.	**Tubercle** T.B. xx.	Nil.	Nil.	Nil.
	61 days	10 nodules of **Tubercle** No T.B. found.	**Tubercle**	Nil.	Nil.	**Tubercle** T.B. xx.	**Tubercle** T.B. xx.	**Tubercle** T.B. x.	Nil.	**Tubercle**	Nil.
	85 days	Nodules of **Tubercle** ulcerating. T.B. x.	**Tubercle**	**Tubercle**	**Tubercle**	**Tubercle**	**Tubercle**	**Tubercle** T.B. x.	**"Grapes"** T.B. x.	**Tubercle** T.B. x.	Nil.
	259 days	25 nodules of **Tubercle** No T.B. found.	**Tubercle** T.B. x.	Nil.	Nil.	**Tubercle**	**Tubercle**	Nil.	**"Grapes"** T.B. x.	Nil.	Retro-hepatic glands and those below jaw; other organs nil.
Human. *Experiment I.* Four calves received at one feeding from one trough: 70 cc. of sputum from two cases of pulmonary tuberculosis (human) containing numerous tubercle bacilli.	33 days	53 nodules of **Tubercle** No T.B. found.	Nil.	Nil.	Nil.	Nil.	Nil.	Nil.	Nil.	Nil.	Nil.
	63 days	63 nodules of **Tubercle** No T.B. found.	Nil.	Nil.	Nil.	Nil.	Nil.	Nil.	Nil.	Nil.	Nil.
	85 days	13 nodules of **Tubercle** T.B. x.	Nil.	Nil.	Nil.	Nil.	Nil.	Nil.	Nil.	Nil.	Nil.
	233 days	Nil.	Nil.	Nil.	Nil.	Nil.	Nil.	Nil.	Nil.	Nil.	Nil.
Experiment II. Two calves received at one feeding 440 cc. of sputum from two cases of pulmonary tuberculosis (human) containing numerous tubercle bacilli.	56 days	13 nodules of **Tubercle** T.B. x.	**Tubercle** T.B. x.	Nil.	Nil.	Nil.	Nil.	Nil.	Nil.	Nil.	Nil.
	138 days	Nil.	Nil.	Nil.	Nil.	Nil.	Nil.	Nil.	Nil.	Nil.	Nil.

spreads in some instances to the other glands and organs of the body. In the milk and meat feeding experiments in pigs the intestines showed no tuberculous lesion; the decision, therefore, that the disease developed as the result of the feeding depended not only on the precautions taken with regard to using pigs that were quite healthy (p. 11), not only on the fact that the stage of the tuberculosis found at death corresponded to the period elapsing after the feeding, but on the fact that one or more groups of the lymph glands in connexion with the alimentary tract were tuberculous. For calves the same remarks hold good, except that in all the animals that became tuberculous there was a lesion of the intestines (small or large gut).

icroscopi-
l diagnosis
tubercu-
us lesion.

48 A microscopical examination was made of all lesions found in the experimental animals, whether tuberculous or not. Caseation and calcification of a lesion is not a diagnostic characteristic of tuberculosis from the point of view of a microscopical examination. Such lesions, when they affect different parts of the body in the more or less definite manner previously described, are characteristic of tuberculosis; but, given a sesies of microscopical preparations for the purposes of diagnosis of tuberculosis, it is not caseation or calcification or the presence of giant cells which is characteristic, but the presence of tubercle bacilli, and these are found when no diagnosis is possible by the naked eye (*see* Plate III., Fig. 7).

49 In one or other part of all recent tuberculous lesions, tubercle bacilli are present; in older chronic lesions they are more difficult to find, and in several series preparations of old lesions no bacilli may be seen at all, even after a most careful examination under a high power of the microscope. In these last cases, it is probable that a more extended microscopical examination would reveal tubercle bacilli in one of the tuberculous lesions present in the body, but a diagnosis in such cases does not rest solely on the microscopical examination, but on the distribution of the lesions, *i.e.*, on the course of the tuberculosis.

50 This is not the place to discuss the number of bacilli in old or new tuberculous lesions; nor the relation of the bacilli to them. The subject will only be considered from the point of view of the diagnosis of tuberculosis from certain lesions met with in the intestines, mesenteric and cœcal lymphatic glands, but chiefly in the liver and spleen of guinea-pigs.

51 In the course of the investigation, a microscopical examination was made of 370 different specimens, of which an average of at least 10 sections was made; so that altogether over 3,700 sections were examined under the miscroscope for tuberculous lesions. Of these 370 specimens, 141 showed tuberculous lesions, about one-fourth were normal, and the remainder showed pathological lesions other than tuberculosis. Early in the investigation it was noted that some of the guinea-pigs showed in the liver and spleen white specks, in some cases each organ showing only one or two points less than half a millimetre in diameter on the surface of the organ; in other cases the liver showing abundant whitish areas, and the spleen projecting white nodules. These white areas were not surrounded by a zone of congestion; they could, if of moderate size, be shelled out of the organ, and the contents were pultaceous: points which, as experience was obtained, enabled a diagnosis to be made from tuberculosis. Other cases occurred in the course of the investigation in which the intestine, the mesenteric and cæcal glands, and even the lungs, were affected with what appeared a similar disease. Besides the fact that in most instances the liver or spleen was the only organ affected, a microscopical examination demonstrated that the majority of the lesions were due to a "bacterial necrosis" of the part, that is, to a localized necrosis of the tissues produced by bacteria (cocci or bacilli), other than the bacillus tuberculosis. Such areas of bacterial necrosis are characterised by a necrosis of the gland tissue itself (Plate IV., Fig. 8), the area being surrounded by a collection of leucocytes, and in some cases by a fibrous capsule. Moreover, in the majority of instances the bacteria are present in large numbers in the necrosed area itself, in others they completely block the vessels surrounding the necrosed area; this latter condition being observed in the liver only. Such lesions as these are easily distinguished from tuberculous ones; not only in their distribution differing from that of tuberculosis, but in the absence of tubercle bacilli. In all cases of tuberculosis in guinea-pigs, tubercle bacilli were readily found in the lesions. In any doubtful lesion of the guinea-pig, it is this absence of tubercle bacilli which renders the diagnosis certain.

Cases of bacterial necrosis occurred which showed that the way of entrance of the bacteria into the body was through the intestines. Thus in one case the intestine alone was affected; in another the intestine, cæcum, and liver; in another the intestine and spleen; in others the mesenteric or cæcal glands, alone or with the liver. Taking all the facts together as shown in the following table (X), they go to show that the mode of infection is by way of the intestine; and that the bacteria may pass through the intestine without affecting the gut, and cause disease in the lymph glands attached to it or without even affecting these may produce lesions in the liver or spleen.

52 Of the 394 experimental guinea-pigs, 58 showed lesions of the kind described; 53 of the fed animals, 5 of the inoculated. Of the 203 non-experimental animals that died, 21 showed these lesions. In only three of the experimental animals was the disease so extensive as to warrant the conclusion that it was the cause of death.

53 TABLE X.

Cases of Bacterial Necrosis in Experimental and Non-Experimental Guinea-Pigs.

Organs affected with Bacterial Necrosis in individual cases.	Experimental Animals. Number affected.		Non-Experimental Animals. Number affected.
	Feeding Experiments.	Inoculation Experiments.	
Liver alone, or liver and gall-bladder.	25	3	9
Liver and spleen alone - -	10	—	4
Spleen alone - - -	8	1	6
Lungs, liver, and spleen - -	1	—	—
Lungs - - - -	2	—	—
Small intestine - - -	1	—	—
Small intestine, cæcum, and liver	1	—	—
Small intestine and spleen -	1	—	—
Cœcum and spleen - - -	1	—	—
Small intestine and cæcal glands	1	—	—
Mesenteric glands - - -	1	—	—
Cœcal glands - - -	—	—	1
Mesenteric glands and liver -	—	1	1
Total - - -	53	5	21

54 Of the cases occurring in the experimental animals, 35 were examined microscopically, those not examined being very slight cases of disease of the liver and spleen, the features of which were well known from previous examinations. Of the 35 specimens examined, the liver showed in 10 cases necrosis due to bacilli or cocci; in six cases the spleen showed similar appearances, in four the mesenteric and cœcal glands (all those that occurred), in two the intestine, and in one the lung. The results of the examination, therefore, quite confirms the evidence of bacterial necrosis in the guinea-pig, and is interesting, as showing the mode of infection through the intestine.

Of the cases occurring in non-experimental animals, five were examined, and the necrosis was found due to cocci in one, viz., in that in which the mesenteric glands were affected.

Another lesion occurred in a few of the experimental and non-experimental guinea-pigs which must be considered as the result of bacterial necrosis. This was an ulcer in the duodenum produced in the pouch which exists in the guinea-pig just beyond the pylorus. In two cases which were examined microscopically the ulceration was distinctly due to the growth of bacteria in the mucous membrane with subsequent necrosis.

Bacterial necrosis is a condition not limited to guinea-pigs. It has been found in sheep and cows. It was present in the pharynx of two of the experimental pigs (fed with the meat of Cow 23, *see* p. 80 and Plate IV., Figs. 9 and 10), in which the necrosis was due to a streptococcus, and it was also seen in the lung of one of the tuberculous cows (No. 12), in which the necrosis was due to staphylococci. This lesion of the cow and a lesion of the lymph glands in one of the pigs already mentioned was an example of mixed infection, since the parts were also tuberculous.

A complete study was not made of this bacterial necrosis, it was only observed in its relations to a diagnosis from tuberculosis. It is of very great interest pathologically, and especially from the point of view of infection by way of the intestine and of intestinal ulceration (*see* Plate IV., p. 106.).

INQUIRY II.

PART II.

REPORT on the EXPERIMENTS with the MEAT of TUBERCULOUS COWS.

Object of the Investigation.

55 To test whether the meat of tuberculous cows was capable of giving the disease to animals fed or inoculated with it.

Method of Procedure.

Carcases.

56 The meat from 21 carcases of tuberculous cows was used for experiment. Ten of the carcases were obtained at the Cattle Market, Islington, from cows which had been slaughtered as "contact" animals in an outbreak of pleuro-pneumonia; none of the carcases used were, however, from cows themselves the subject of pleuro-pneumonia. Eleven of the carcases were those of milch cows purchased by the Commission. In these a complete post-mortem examination was made, but in those obtained from the slaughter-house, the examination had to be limited to the pleura, peritoneum, lungs, kidneys, and some of the lymphatic glands, the other organs having been removed before the examination was made. (For a full record of the post-mortems and microscopical examination of the tuberculous lesions, *see* Part V., p. 47).

Treatment of the Meat.

Removal of meat from carcase.

57 After the examination of the carcase, portions of the meat were cut out either by the butcher, as in the animals examined at the slaughter-house, or by my assistant or myself, as in the case of the animals belonging to the Commission.

The portions of the rump and loin removed were between one and three pounds in weight. When the breast was used it was cut off in as large slices as possible; when the intercostal muscles and the diaphragm were required, several ribs, with the diaphragm attached, were cut out in one piece.

Directly after the meat was cut away, it was placed in large sterilized stoppered glass jars* for conveyance. The meat, therefore, was not touched by anyone except the butcher, my assistant, or myself, and great care was exercised to prevent the meat touching any obviously tuberculous mass, or being excised with a knife obviously smeared with tuberculous material.

Preservation of the meat.

58 The meat was preserved in an ice-safe while it was being used for experiment. As a rule, it kept well for a fortnight. Some specimens were evidently poor in quality, as they did not keep well, but the meat of the majority of carcases used kept very well. The ice-safe was in every instance thoroughly washed out with soap and water, and then with boiling water after it had contained one lot of meat, and the racks on which the meat rested were sterilized (after thorough washing) by boiling in water for two hours. In all cases, therefore, it was considered that the ice-safe was aseptic as regards the places where the meat was placed.

Trimmed and untrimmed meat.

59 The meat as obtained was considered as belonging to one of two classes. It was thought that the butcher's knife, hands, or cloth, might be a means of contaminating the cut surfaces of the piece of meat with tuberculous material. This might happen in several ways. In removing the organs from a tuberculous cow, the butcher's knife in many instances cuts into a tuberculous lesion, and this is especially liable to occur if the pleura or peritoneum is affected in the form, which is so common in the cow, of large bunchy "grapes." These "grapes" are highly infective (*see* Part IX., p. 100), and considering that a tuberculous lesion consists of smeary fatty matter, it was only too probable that some of this infective material would be rubbed over the cut surfaces of the meat. To remove this possible layer of infective matter, the meat was "trimmed," *i.e.*, with a sterilized knife† at least one-eighth of an inch of the meat nearest the cut surface was removed and thrown away. The meat from which the original cut surface had not been removed was called "untrimmed." In all cases, whether trimmed or untrimmed, fat, tendons and lymph-glands in the intermuscular spaces were removed from the meat used for experiment. It was not thought that the surface of the meat was "sterilized" by this method of trimming; sterilization of the surface of the meat could only be done by some such method as heat applied to it (the naked flame of a Bunsen burner, the action of boiling water) or of a strong antiseptic. But it was thought that by trimming, most of the tuberculous material which might accidentally contaminate the meat, would be removed.

Method of feeding.

60 Before feeding the guinea-pigs or rabbits, the meat was minced in a mincing-machine, which was sterilized each time after using by thoroughly washing and boiling for two hours in water. The minced meat was then mixed with the sterilized food of the animals. Four guinea-pigs, as a rule, were placed in one cage for feeding experiments, and it was found, as the investigation proceeded, that these animals could easily eat 100 grammes of minced meat between them in the 24 hours. If all the food had not been eaten, the pan was allowed to remain in the cage until it was emptied. Another 100 grammes with ordinary food was then given, and so on day after day. It was found that more than 100 grammes of meat daily might make the animals ill. One rabbit could eat 100 grammes of meat in 24 hours, and the same procedure was employed as in the case of the guinea-pigs. When pigs were used for experiment, the meat was not usually minced, but simply cut up into small pieces with a sterilized knife; about one kilogram (2 lbs.) of meat was given to each pig daily; no other food being allowed during the meat feeding.

Amount of meat given and duration of feeding.

61 The number of meat feeding experiments performed on guinea-pigs were 35, the meat from 20 cows being used. In 31 experiments four guinea-pigs were fed in the same cage; in four, only two were used. The following table shows the average amount of meat each guinea-pig received. The four guinea-pigs were chosen of about the same size, and as far as possible, bucks only, or does only, were used. They were placed in the same cage, and fed from the same pan. It was found best to use four animals, as experience showed that one, two, or more might die before any tuberculous lesion could be developed.

62 TABLE XI.

Guinea pigs.

Total number of MEAT-FEEDING Experiments in GUINEA-PIGS, **35**. Four guinea-pigs were used in 31 of the experiments, and in the other four 2 guinea-pigs. Of these **17** were with trimmed, **18** with untrimmed, meat.

Average weight of meat in grammes eaten by each guinea-pig.	Number of experiments.	Duration of feeding.
58 to 100 - -	4	2 to 4 days.
100 to 200 - -	17	2 to 11 „
201 to 300 - -	9	4 to 12 „
350 - - -	5	14 „

Besides these one feeding experiment with one guinea-pig was made with untrimmed meat juice.

63 TABLE XII.

Rabbits.

Total number of MEAT-FEEDING Experiments in RABBITS, **5**. Of these, **1** was with trimmed, **4** with untrimmed, meat. One rabbit only used in each experiment.

Amount of meat eaten in grammes.	Number of experiments.	Duration of feeding.
475 to 570 - -	4	4 to 6 days.
960 - - -	1	10 „

One other rabbit was fed with untrimmed meat juice.

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* These glass jars were sterilized by washing thoroughly with fuming nitric acid and sand, then with boiling water, and then sterilized distilled water. If necessary, alcohol or ether was finally used.

† The knife was sterilized by washing with soap and water, drying, and passing through the flame of a Bunsen burner.

64 TABLE XIII.

Total number of MEAT-FEEDING Experiments in PIGS, **6**. Of these, **3** were with trimmed, **3** with untrimmed.

Amount of meat eaten in grammes.	Number of pigs in each experiment.	Duration of feeding.
2,381 - -	2	3 days.
8,100 - -	2	3 "
3,000 - -	1	3 "
3,720 - -	1	4 "
5,700 - -	1	6 "
6,110 - -	1	7 "

Continuous and daily feeding of the animals was adopted as the method of experiment for testing the infectivity of meat. When obvious* tubercular material is used (whether sputum from a phthisical patient or a tuberculous lesion from a cow), a single feeding, and a small amount is sufficient to give tuberculosis to guinea-pigs, rabbits, or pigs (Part I., p. 13). Meat, as a rule, does not obviously contain tuberculous lesions (*see* examination of the meat, p. 24). Tubercle, or "pearls" in meat are rarely discoverable either by the naked eye or by microscopical examination. If meat, therefore, were infective at all, it would have to be given in large doses, and continuously for some time to produce tuberculosis; a single meat feeding would not be a sufficient test of the infectivity.

noculation xperiments.

65 Inoculation experiments were made both with the meat and the meat-juice, chiefly in guinea-pigs, a few rabbits only being used. Inoculations were made from 20 carcases, from 16 of which 29 animals were inoculated with meat, and from nine of which 19 inoculations were made with meat juice; *i.e.*, 48 inoculations in all with the meat or meat-juice of the 20 cows, 20 of trimmed meat, 28 of untrimmed.

Vith meat.

66 The method adopted for the inoculation with meat was as follows: with a sterile knife a small incision was made just inside the nipple of a guinea-pig or rabbit, and a piece of meat, not quite as large as a split pea, placed by means of sterile forceps in the subcutaneous tissue. In every case the inoculation was made in *both* groins, so that it could be observed whether tuberculosis developed from both or from only one inoculation. As a rule, the small wounds made were closed in less than 24 hours, and healed normally in a few days; but the piece of meat could still be felt as a small nodule under the skin for a week or longer. In a few instances a little suppuration at the edge of the wound occurred, healing in less than a fortnight, while in still fewer an abscess developed (*see* Part I., p. 11).

Vith meat uice.

67 The meat-juice used for inoculation was not mechanically expressed from the meat, but was the liquid which collected at the bottom of the sterile jars in which the trimmed or untrimmed meat was preserved for feeding purposes. This liquid collected after a day or two. It was clear, and of a dark red colour, strongly acid (due to sarcolactic acid) and consisted not only of the serum whch exudes from the muscle after rigor mortis has passed off, but of the blood-stained serum contained in the vessels of the muscle. Most of the meat from which the juice was obtained was minced, so that if the meat was infective the juice in collecting at the bottom of the vessel would be likely to carry with it some of the infective material, *i.e.*, the tubercle bacilli.

In guinea-pigs, one cubic centimetre was usually injected under the skin of each groin with a sterilized syringe; in some cases the injection was made only on one side. In rabbits the dose given varied from 1cc. to 10cc; the inoculation being made on each side, as a rule. The liquid was in all cases rapidly absorbed.

RESULTS OF THE POST-MORTEM EXAMINATION OF THE COWS, AND OF THE EXAMINATION OF THE MEAT.

68 Having made clear the method of procedure with regard to the experiments, and the precautions observed in carrying them out, the results of (1) the examination of the carcases as regards the degree of tuberculosis, and (2) of the naked eye and microscopical examination of the meat, will be discussed; and then the experiments with the meat as regards its infectivity. The full details of each post-mortem, of the experiments, and of the microscopical examination of all the lesions both in the cows and in the experimental animals, will be found in Parts V. and VII. of the Report.

Degrees o tuberculo in the carcases examined.

69 An examination of the degree of tuberculosis in the carcases from which meat was obtained for experiment was deemed of great practical importance at the commencement of the investigation; and this opinion was more and more strengthened as the work proceeded. The carcases were obtained as opportunity occurred, and no special attention was paid to the degree of tuberculosis (except to record it) while the investigation was proceeding. The meat from cows in all stages of the disease was used.

70 A complete pathological classification of all the cases is not possible, since, in the case of the cows examined at the cattle market some of the organs had been removed. In the cow, tuberculosis starts, as a rule, either from the lungs and pleura, or from the intestines; the lungs and pleura most frequently; and as these were examined in all the cows, the incompleteness of the post-mortem examination of the animals seen at the slaughter-house does not lead to any great source of error in classifying the cases of tuberculosis. The distinction that is of practical importance is between the cows with "local tuberculosis" and those with "generalised." To the first class belong those cases in which the disease is limited either to the pleura or lungs and pleura with the lymphatic glands (bronchial and mediastinal) in the thorax; or to the intestines and mesenteric glands, and one or other of the organs of the abdomen, *i.e.*, liver or spleen. To the second class belong cases with local tuberculosis in the thorax or abdomen, but also with tuberculosis spreading into the other body cavity (abdomen or thorax). Thus, it was found that with the intestines and mesenteric glands affected, the lungs and lymphatic glands of the thorax would be also tubercular, showing that the disease was becoming generalised; and that with the lungs tubercular, the disease might also be present in the lymph glands of the abdomen. Although, from some points of view, this regional classification of cases of tuberculosis is the best, yet, if adopted exclusively, it does not clearly show one feature of tuberculosis, viz., the size of the tubercular lesion. For tuberculosis in any given case may be slight as regards the size of the lesions, and yet be generalising; or it may be advanced and yet be localised. The effect on the functions of the body does not depend solely on the number of lesions, but on the extent to which the lesions have advanced so as to destroy the organ affected. This consideration may be accepted as true, but I regard it as subject to limitations consequent on the slowly progressive character of tuberculosis.

71 The classification of tuberculous cows I have adopted will probably enable the results of the experiments with the meat to be estimated more correctly, viz., that of dividing the cows into: (1) those with *mild tuberculosis:* (2) with *moderate tuberculosis:* (3) with *advanced and generalised tuberculosis.* Some of the cows classed under (1) and (2) are cases of local tuberculosis commencing to generalize; these are specified in the following list, in which the parts chiefly affected with the disease are in italics, the parts less affected being in ordinary type:—

1. *Cases of mild tuberculosis.*—8 cows. Only organs affected with tubercle are mentioned:—
    - *Cow No. 1 (Cattle market).—*Left pleura* (lower ⅓); one small tuberculous nodule in left lung.
    - Cow No. 2 (Cattle market).—Diaphragmatic *pleura* and *peritoneum.*
    - Cow No. 3 (Cattle market).—*Bronchial and posterior mediastinal glands.*
    - Cow No. 4 (Cattle market).—Both *pleuræ: bronchial and posterior mediastinal glands:* two lumbar glands.
    - Cow No. 5 (Cattle market).—*Both pleuræ:* a few miliary tubercles in lungs; *bronchial and posterior mediastinal glands.*
    - Cow No. 6 (Cattle market).—*Both pleuræ:* slight tuberculosis of lungs; also of mediastinal and bronchial, and of one or two pelvic glands.

In all these Cattle market carcases the lungs were examined; but the intestines, mesenteric glands, liver, and spleen were not. All the carcases (except perhaps

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* Obvious, *i.e.*, either to the naked eye or to microscopical examination.

* The numbers of these cows are the same throughout the Report.

No. 4) were "well" nourished or "moderately well" nourished, and would have passed inspection. In both Nos. 4 and 6 tuberculosis was present (although in an early stage) in the lumbar glands; it was, therefore, becoming generalised.

In the two following cases a complete post-mortem was made :—

Cow No. 7 (milch cow, Harrow*).—Lungs: two caseous nodules. *Liver*, bronchial, *posterior mediastinal glands*, and *glands in lesser omentum.*

Cow No. 8 (milch cow, Harrow).—Intestines, *mesenteric glands*, glands in lesser omentum, *udder.*

Cow No. 7 is doubtfully classed as mild tuberculosis; the disease was becoming generalised, and the animal was greatly emaciated. Cow No. 8 was distinctly a mild case of tuberculosis. It was well-nourished, and although the tuberculosis was well-marked in the udder, this gland can be considered as somewhat outside the points of view from which we are now regarding the disease, viz., in its relation to the infective properties of the meat.

With the exception of two cows (Nos. 4 and 7), all the cases of mild tuberculosis were observed in well-nourished animals.

2. *Cases of moderate tuberculosis.*—Eight cows :—

Cow No. 10 (Cattle market).—*Lungs : bronchial, posterior mediastinal, pelvic* and *popliteal glands.*

Cow No. 14 (Cattle market).—*Pleuræ* (lower part) : *lungs, bronchial and posterior mediastinal glands.*

Both these animals were well-nourished. Cow No. 10 showed generalisation of tuberculosis from the thoracic organs to the lymphatic glands of the abdomen and of the hind quarters.

In the following cases a complete examination was made :—

Cow No. 9 (Veterinary College).—*Lungs : Bronchial and posterior mediastinal glands, one gland below diaphragm, lumbar glands : muscle of rump.*

Cow No. 11 (milch cow, Harrow).—*Lungs:* one bronchial gland, liver.

Cow No. 12 (milch cow, Harrow).—*Lungs : posterior mediastinal glands :* muscle of rump.

Cow No. 13 (milch cow, Harrow).—*Lungs : bronchial and posterior mediastinal glands.*

Cow No. 15 (milch cow, Harrow).—Pleuræ ; *lungs,* bronchial, anterior and *posterior mediastinal glands.*

Cow No. 16 (milch cow, Harrow).—*Lungs : anterior and posterior mediastinal and bronchial glands ;* intestines.

In all these cases the carcase was wasted. In three the disease was generalising ; in three it was not.

3. *Cases of advanced and generalised tuberculosis.*—Five cows :—

Cow No. 19 (Veterinary College).—*Pleuræ, pericardium, peritoneum ; lungs ; udder ; mediastinal and bronchial glands.*

Cow No. 20 (milch cow, Harrow).—Pleuræ, peritoneum ; *lungs ; bronchial, posterior mediastinal, sub-diaphragmatic, mesenteric, and lumbar glands ; intestines, udder.*

Cow No. 21 (milch cow from Denmark).—*Pleuræ ; lungs ; intestines, bronchial, mediastinal, lumbar, cæcal, mesenteric, and iliac glands ; udder, uterus.*

Cow No. 22 (milch cow, Harrow).—*Pleuræ, peritoneum ; lungs ; kidneys ; uterus ; anterior and posterior mediastinal, bronchial, and mesenteric glands ;* intestines.

Cow No. 23 (milch cow, Harrow).—*Pleuræ, peritoneum ; lungs ;* kidneys ; *anterior and posterior mediastinal, bronchial, and mesenteric glands.*

In all these cases the carcase was much wasted.

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72 Special attention was paid to the presence of tuberculosis in any part of the carcase after it had been hung and "dressed" by the butcher. In this process of dressing all the internal organs are removed with the exception of the kidneys, embedded in their fat. The kidneys are not commonly affected with tuberculosis. The condition of the kidneys is recorded in 19 post-mortems on tuberculous cows ; in only four of these were they affected, and all four cases were the subject of advanced and generalised tuberculosis. The presence of tuberculosis in the kidneys may therefore be some criterion of the degree of tuberculosis which has been present in a cow, the carcase of which is under inspection. Attention was, however, more specially paid to the lymphatic glands of the lumbar regions, and in the popliteal spaces. The lumbar lymphatic glands are sometimes removed during the dressing of the carcase ; the cervical glands are almost invariably absent from the dressed carcase ; the popliteal glands are always present, but to expose them an incision has to be made into the muscles, a proceeding which would damage the carcase for sale. The results of the examination of the lumbar and popliteal lymphatic glands in the cows are seen in the following table :—

73 TABLE XIV.

——	Popliteal Glands.	Lumbar Glands.
Mild tuberculosis. 8 cows - - -	In 7 normal - 1 not examined -	In 6 normal. In 2 recent tuberculosis.
Moderate tuberculosis. * 10 cows - -	In 8 normal - In 1 caseous tubercle. 1 not examined -	In 8 normal. In 2 caseous tuberculosis.
Generalised tuberculosis. 5 cows - -	In 3 normal - 2 not examined -	In 1 normal. In 3 tuberculosis. 1 not examined.
Summary - -	19 cows ; in 1, tubercular popliteal glands.	22 cows ; in 7, tubercular lumbar glands.

* *Note.*—Including two cases (of milch cows) in which the meat was not used for experiment.

Special reference must be made to the cow (No. 10), with moderate tuberculosis, which showed tuberculosis of the popliteal glands. This was a carcase seen at the Cattle-market, dressed, and ready for sale. The lungs were the seat of advanced caseous tuberculosis, as were the posterior mediastinal and bronchial glands, but there was also advanced disease of the lumbar and of all the glands in the pelvis, an unusual occurrence, judging from the other cases (23 in number), of tuberculosis examined.

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74 As to the general condition of the carcases examined, in proportion to the degree of tuberculosis they were wasted, the fat disappearing and when present of an orange colour ; the carcase being wet, a condition due to the sodden character of the connective tissue. All the carcases of the cows with generalised tuberculosis presented these characters, and seven out of eight of those with moderate tuberculosis, one only being described as "moderately well nourished and moderately fat." Of the eight cases of mild tuberculosis five were moderately well nourished, and one of these presented the normal appearance of a well-nourished cow. Except in two instances, to be described presently, the meat showed no great distinction from the normal. In many cases it was dark in parts and pale in parts, in others it was somewhat sodden, while in some (especially in the cases of mild tuberculosis) it was firm and of good colour.

75 During the process of cutting up and mincing the meat, a close naked-eye examination was made for the presence of tubercle in the muscle. In only one case out of 22 cows was this found ; it is described separately. In the other 21 cows, the meat showed no gross lesion of the disease, but in one case microscopic tubercle was found. In 20 cases, therefore, the meat presented no tuberculosis, either to the naked eye or to microscopical examination. An average of about 10 microscopical sections was made of the meat from each cow, cover-glass preparations being also made of the juice. The results are shown in the following table :—

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* That is, slaughtered at Harrow.

TABLE XV.

76 Microscopical Examination of the Meat and Meat-Juice.

Number of Cow.	Portion of carcase examined microscopically.	Number of Sections cut.	Result.	No. of cover-glass preparations of Juice.	Result.
			Mild tuberculosis. 7 Cows.		
1	Rump	8	Normal	—	—
2	Rump	6	Normal	—	—
3	Rump	6	Normal	—	—
4	Rump	7	Normal	10	No T. Bacilli.
	Loin	6	Normal	10	No T. Bacilli.
	Breast	11	Normal	10	No T. Bacilli.
5	Rump	8	Normal	—	—
6	Rump	9	Normal	4	No T. Bacilli.
8	Rump	12	Normal	—	—
			Moderate tuberculosis. 9 Cows.		
9	Intercostals	7	Normal	—	—
	Rump	12	5 normal; 7 interstitial fibrosis.	—	—
	Rump	13	Caseous nodules of TUBERCLE.	—	—
10	Rump	9	Normal	9	No T. Bacilli.
11	Rump	7	Normal	—	—
12	Rump	9	One miliary TUBERCLE.	—	—
13	Rump	9	Normal	—	—
14	Rump	6	Normal	—	—
15	Rump	9	Normal	—	—
16	Rump	10	Normal	—	—
17	Rump	9	Normal	—	—
	Intercostals beneath "grapes."	10	Normal	—	—
			Generalised tuberculosis. 5 Cows.		
19	Rump	7	Normal	—	—
	Rump	38	Well - marked fibrosis; no caseation.	—	—
	Intercostals	9	Normal	—	—
20	Rump	9	Normal	10	No T. Bacilli.
	Breast	10	Normal	10	No T. Bacilli.
21	Breast	9	Normal	10	No T. Bacilli.
22	Rump	9	Normal	—	—
23	Rump	13	Normal	—	—
	Intercostals	11	Normal	—	—

In the cases of mild tuberculosis, therefore, no tubercle was found in the meat, either by naked eye or by microscopical examination; in those of moderate tuberculosis, tubercle was found in the meat in two cases. The rest were normal to naked eye and microscopical examination. In one case (Cow 19) with advanced and generalised tuberculosis, in one part of the rump over an extent of 6 inches by 2 inches there were a large number of yellowish fibrous areas. On microscopical examination, interstitial fibrosis of the muscle was seen, but no caseation and no tubercle bacilli. It may have been an old tubercular lesion, but there was no evidence of its being so.

Cases of tuberculosis in meat.

77 The two cases of tuberculosis in meat will now be considered. They both occurred in the rump; one was seen with the naked eye; one was visible only under the microscope.

CASE 1.—(Cow No. 9, Moderate Tuberculosis). In one part of the rump of one side, on cutting up the muscle, there was an area 2½ inches in diameter, surrounded by very tough connective tissue, and pale muscular tissue. In this area there were numerous whitish yellow (caseous) nodules, the size of a split pea to a pea. *Microscopical examination.*—The nodules on microscopical examination showed the structure of tubercle, viz., a collection of small cells, which had undergone caseation for the most part. No tubercle bacilli were found, but the structure of the nodules and the presence of tubercle in the animal were sufficient to diagnose the lesion. Around the area of caseous nodules there was a great deal of connective tissue between the muscle fibres (interstitial fibrosis), while a short distance outside the area described the muscle fibres were quite normal. The diagnosis of this lesion was therefore an *old focus of caseous tubercle.*

78 CASE 2. (Cow No. 12, Moderate Tuberculosis).—This case was one of some interest, since, to the naked eye, the meat was perfectly normal, but on microscopical examination, one miliary tubercle was found between the muscle fibres. This tubercle, as is seen in the accompanying figures (Plate I.), is a collection of leucocytes around two vessels; no caseation has as yet occurred. That it was a tubercle is shown by the fact that a tubercle bacillus was found (*see* Fig. 2).

The following points may be stated by way of a summary:—

1. Tubercle in muscle is rare either on naked eye or on microscopical examination. Tubercle bacilli were not found free in the muscle or in the juice unless a tubercular lesion was also present.

2. When tubercle is present in the muscle, it is always localised. The muscular tissue appears to be antagonistic to the growth of the tubercle bacillus and to prevent its spread to neighbouring parts, as has been shown by other observers.

The cases in which tubercle of the muscle was found occurred in cows previously injected with Koch's tuberculin; Cow No. 9 sometime previously to slaughtering, Cow No. 12 only two days before. As Koch's tuberculin, when injected into a tuberculous animal, may lead to generalisation of the disease, it is not accurate to decide that the case of Cow No. 9 was necessarily an instance of natural tubercle of the muscle in the cow, *i.e.*, that it was a case which would have occurred in the ordinary course of the disease in the cow.

79 Results of the Experiments to test the Infectivity of Meat by Feeding and Inoculation.

Experiments with the meat.

The method of procedure in using the meat for experiment has been already fully described. The results of the experiments can be best set forth in three tables: one for the cases of mild tuberculosis, (Table XVI.) the second for those of moderate tuberculosis, (Table XVII.) and the last for those of the advanced and generalised disease (Table XVIII.). In these, all the animals (guinea-pigs, rabbits, pigs) used for experiment are enumerated. It is necessary to explain that in the first column where the part of the cow affected by tuberculosis is in black type, the disease was advanced in that region, and that all cases of tubercle in the experimental animals are also in black type. These cases of tubercle were diagnosed, not only by the naked eye, but by microscopical examination. (For the full details, *see* Part VII.)

The headings of the columns in the tables are explanatory of the data given.

80 TABLE XVI.

SHOWING THE RESULT of the EXPERIMENTS with the MEAT of COWS the subject of MILD TUBERCULOSIS.

No. of Cow. — Parts affected with Tuberculosis.	INOCULATION EXPERIMENTS.			Portion of Carcase used.	FEEDING EXPERIMENTS.				**Trimmed or untrimmed Meat.**
	No. of Animals.	Meat or Juice.	Result.		No. of Animals used in each Experiment.	Amount of Meat eaten, in Grammes.	Result with the Animals that lived long enough for Tuberculosis to develop, *i.e.*, over 28 Days from first Feeding.		
							No of Animals.	Result.	
1. Pleura.	2 guinea-pigs.	Meat.	Nil.	**Rump.** **Intercostals and diaphragm.**	4 guinea-pigs. 1 rabbit.	1,000 500	2 1	Nil. Nil.	**Untrimmed.**
2. Pleura, peritoneum.	2 guinea-pigs. 1 rabbit. 2 guinea-pigs. 1 rabbit.	Meat. Juice, 6 cc. Meat. Juice, 10 cc.	Nil. Nil. Nil. Nil.	**Rump.**	1 rabbit. 4 guinea-pigs. 2 guinea-pigs. 4 guinea-pigs. 1 rabbit.	475 580 250 cc. juice. 600 500	1 4 2 4 1	Nil. Nil. Nil. Nil. Nil.	**Trimmed.** **Untrimmed.**
3. Lymphatic glands of thorax.	1 guinea-pig.	Meat.	Nil.	**Rump and loin.**	4 guinea-pigs.	650	2	Nil.	**Trimmed.**
4. Pleura, lymphatic glands in thorax, lumbar glands.	2 guinea-pigs.	Meat.	Nil.	**Rump.** **Breast** **Loin.**	4 guinea-pigs. 2 guinea-pigs. 4 guinea-pigs.	1,000 200 800	4 2 4	Nil. Nil. Nil.	**Trimmed.**
5. Pleura, lymphatic glands in thorax.	1 guinea-pig.	Meat.	Nil.	**Rump and loin.**	4 guinea-pigs.	950	4	Nil	**Trimmed.**
6. Pleura, lymphatic glands in thorax, lumbar glands.	1 guinea-pig. 1 guinea-pig. 1 rabbit.	Juice, 0·6 cc. Juice, 0·6 cc. Juice, 2 cc.	Nil. Nil. **Tuberculosis.**	**Rump.** **Rump**	4 guinea-pigs. 1 pig. 4 guinea-pigs.	1,400 5,700 1,385	2 1 3	Nil. Nil. Nil.	**Trimmed.** **Untrimmed.**
7. Liver, lymphatic glands in thorax, lungs.	1 guinea-pig.	Meat.	Nil.	**Rump.**	4 guinea-pigs. 4 guinea-pigs.	800 800	2 1	Nil. Nil.	**Untrimmed.**
8. Intestines, mesenteric glands, udder.	2 guinea-pigs. 1 guinea-pig.	Juice, 2 cc. Meat.	Nil. Nil.	**Rump.**	4 guinea-pigs. 4 guinea-pigs.	800 800	1 1	Nil. Nil.	**Untrimmed.**
General result, 8 cows.	**19 animals inoculated.**	**12 with meat, 7 with meat-juice.**	**1 developed tuberculosis.**	—	—	—	**42 animals fed.**	**None developed tuberculosis.**	**24 trimmed, 18 untrimmed.**

81 A. That is (Table XIX.), in experimenting with the meat from 21 cows in varying stages of tuberculosis, of 48 animals inoculated with the meat or meat-juice, 10 developed tuberculosis; of 102 animals (guinea-pigs, rabbits, pigs) fed with the meat, six developed tuberculosis. These positive results were obtained from the meat of eight of the cows, viz., of one cow with mild tuberculosis, of three with moderate, and of four with advanced and generalised tuberculosis.

B. If the cases of advanced and generalised tuberculosis are excluded from consideration, it is seen that in experiments with the meat of 16 cows, the subjects of a mild or a moderate degree of tuberculosis, the following results were obtained: Of 35 animals inoculated with the meat or meat-juice, five developed tuberculosis, and of 81 animals fed with the meat, not one showed any signs of the disease.

C. With the meat or meat-juice of four cows the subject of generalised tuberculosis, 13 animals were inoculated, five developing tuberculosis; with the meat of four cows 21 animals were fed, six developing tuberculosis.

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82 It is quite clear that although the meat of cows, the subject of a mild tuberculosis or of a moderate degree of the disease, when given to animals (guinea-pigs, rabbits, and pigs) with their food, does not give tuberculosis, yet the meat as removed from the carcase does contain, in some instances, a certain amount of tuberculous material, from the fact that the meat or meat-juice of five of the cows produced tuberculosis by inoculation. The infective material, therefore, although it may be in sufficient amount to produce tubercle by inoculation in a few of the experimental animals, is *not* sufficient to produce the disease by feeding. This difference between the results of experiments by inoculation and by feeding may be shown in the following table (Table XX., p. 29), in which the positive results of inoculation experiments can be contrasted with the negative results of feeding with the meat from the same carcase.

TABLE XVII.

83 SHOWING the RESULT of EXPERIMENTS with the MEAT of COWS the subject of MODERATE TUBERCULOSIS.

No. of Cow. — Parts affected with Tuberculosis.	INOCULATION EXPERIMENTS.			Portion of Carcase used.	FEEDING EXPERIMENTS.				**Trimmed or untrimmed Meat.**
	No. of Animals.	Meat or Juice.	Result.		No. of Animals used in each Experiment.	Amount of Meat eaten, in grammes.	Result with the Animals that survived long enough for Tuberculosis to develop, *i.e.*, 28 Days from first Feeding.		
							No. of Animals.	Result.	
9. Lungs, lymphatic glands in thorax, lumbar glands.	1 guinea-pig.	Meat.	**Tuberculosis.**	**Rump.**	4 guinea-pigs.	724	4	Nil.	**Trimmed.**
				Rump with visible tubercle.	2 guinea-pigs.	450	2	Nil.	
				Intercostals and diaphragm.	2 guinea-pigs.	230	2	Nil.	
10. Lungs, lymphatic glands in thorax, lumbar, pelvic, popliteal glands.	1 guinea-pig.	Juice, 2 cc.	Nil.	**Rump.**	4 guinea-pigs.	1,400	1	Nil.	**Trimmed.**
				Rump.	1 guinea-pig.	62 cc juice.	1	Nil.	**Untrimmed.**
11. Lungs, lymphatic glands in thorax.	2 guinea-pigs.	Meat.	Nil.	**Rump.**	4 guinea-pigs.	900	4	Nil.	**Untrimmed.**
					1 rabbit.	570	1	Nil.	
12. Lungs, lymphatic glands in thorax.	1 guinea-pig.	Meat.	Nil.	**Rump.**	1 rabbit.	960	1	Nil.	**Untrimmed.**
	1 guinea-pig.	Juice, 2 cc.	Nil.		4 guinea-pigs.	1,160	3	Nil.	
					1 pig.	6,110	1	Nil.	
13. Lungs, lymphatic glands in thorax.	1 rabbit.	Meat.	**Tuberculosis.**	**Rump.**	4 guinea-pigs.	600	2	Nil.	**Untrimmed.**
	1 rabbit.	Juice, 2 cc.	**Tuberculosis.**						
14. Pleura, lungs, lymphatic glands in thorax.	1 guinea-pig.	Meat.	Nil.	**Rump and loin.**	4 guinea-pigs.	950	4	Nil.	**Trimmed.**
15. Pleura, **lungs, lymphatic glands in thorax.**	1 guinea-pig.	Meat.	Nil.	**Rump.**	4 guinea-pigs.	700	2	Nil.	**Trimmed.**
	1 guinea-pig.	Juice, 1 cc.	**Tuberculosis.**		1 pig.	3,720	1	Nil.	
	1 guinea-pig.	Meat.	Nil.	**Rump.**	4 guinea-pigs.	500	2	Nil.	**Untrimmed.**
16. Lungs, intestines, mesenteric, and glands in thorax.	1 guinea-pig.	Juice, 2 cc.	Nil.	**Rump.**	4 guinea-pigs.	1,400	4	Nil.	**Trimmed.**
	1 rabbit.	Juice, 8·5 cc.	Nil.						
	1 guinea-pig.	Juice, 2 cc.	Nil.	**Rump.**	4 guinea-pigs.	1,400	4	Nil.	**Untrimmed.**
	1 rabbit.	Juice, 10 cc.	Nil.						
General result. 8 cows.	**16 animals inoculated.**	**8 with meat, 8 with meat-juice.**	**4 developed tuberculosis; 2 trimmed, 2 untrimmed.**	—	—	—	**39 animals fed.**	**None developed tuberculosis.**	**20 trimmed, 19 untrimmed.**

TABLE XVIII.

84 SHOWING the RESULT of EXPERIMENTS with the MEAT of COWS the subject of ADVANCED and GENERALISED TUBERCULOSIS.

No. of Cow. Parts affected with Tuberculosis.	INOCULATION EXPERIMENTS.			Portion of Carcase used.	FEEDING EXPERIMENTS.				Trimmed or untrimmed Meat.
	No. of Animals.	Meat or Juice.	Result.		No. of Animals used in each Experiment.	Amount of Meat eaten, in Grammes.	Result with the Animals that survived long enough for Tuberculosis to develop; *i.e.*, 28 Days from the first Feeding. No. of Animals.	Result.	
19. Pleura, lungs, udder, lymphatic glands in thorax.	—*	—*	—*	**Rump.** **Intercostals and diaphragm.**	4 guinea-pigs. 2 guinea-pigs.	230 400	1 2	Nil. Nil.	**Trimmed.**
20. Pleura, **peritoneum, lungs, intestines, thoracic, and lumbar glands, udder.**	1 guinea-pig.	Meat.	Nil.	**Rump.** **Intercostals and diaphragm.** **Rump and intercostals.**	4 guinea-pigs. 4 guinea-pigs. 2 pigs.	908 908 2,381	2 1 2	**1 tuberculosis.** **1 tuberculosis.** **2 tuberculosis.**	**Untrimmed.**
21. Pleura, lungs, intestines, thoracic and lumbar glands, udder.	1 guinea-pig.	Meat.	Nil.	**Breast.** **Loin.** **Rump and intercostals.**	4 guinea-pigs. 4 guinea-pigs. 2 pigs.	574 474 8,100	2 2 2	**1 tuberculosis.** Nil. **1 tuberculosis.**	**Untrimmed.**
22. Pleura, peritoneum, **lungs, intestines, thoracic glands,** kidneys, **uterus, lumbar glands.**	2 guinea-pigs. 2 guinea-pigs. 2 guinea-pigs. 1 guinea-pig.	Meat. Juice, 1 cc. and 2 cc. Meat. Juice, 2 cc.	Nil. **2 tuberculosis.** Nil. Nil.	**Rump.** **Rump.**	4 guinea-pigs. 1 pig. 4 guinea-pigs.	400 3,000 350	3 1 3	Nil. Nil. Nil.	**Trimmed.** **Untrimmed.**
23. Pleura, peritoneum, lungs, intestines, **thoracic glands,** kidneys, axillary glands.	2 guinea-pigs. 2 guinea-pigs.	Meat. Meat.	**1 tuberculosis.** **2 tuberculosis,**	**Rump.** **Rump.**	—† —†	—† —†	—† —†	—† —†	**Trimmed.** **Untrimmed.**
General result, 5 cows.	**13 animals inoculated.**	**10 with meat, 3 with meat-juice.**	**5 developed tuberculosis, 2 trimmed, 3 untrimmed.**	—	—	—	**21 animals fed.**	**6 developed tuberculosis, all untrimmed.**	**7 trimmed, 14 untrimmed.**

The results given in the preceding tables may be summarised as follows :—

TABLE XIX.

85 SUMMARY OF THE RESULTS OF EXPERIMENTS WITH MEAT.

Number of Cows and Degree of Tuberculosis.	Number of Animals Inoculated with		Number of Animals that developed Tuberculosis with		Number of Animals fed with		Number of Animals that developed Tuberculosis with	
	Trimmed Meat.	Untrimmed Meat.	Trimmed Meat.	Untrimmed Meat.	Trimmed Meat.	Untrimmed Meat.	Trimmed Meat.	Untrimmed Meat.
Mild Tuberculosis. Eight cows - -	8	11	None.	1 Tub.	24	18	None.	None.
Moderate Tuberculosis. Eight cows - -	6	10	2 Tub.	2 Tub.	20	19	None.	None.
Generalised Tuberculosis. Five cows - -	6‡	7‡	3 Tub.	2 Tub.	7‡	14‡	None.	6 Tub.
Total, 21 cows -	20	28	5	5	51	51	None.	6 Tub.
	48 animals inoculated.		10 developed tuberculosis.		102 animals fed.		6 developed tuberculosis.	

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* The meat of this cow was not used for inoculation.

† The meat was used for feeding pigs, but the experiments were not included in this Table for the reasons given in Part I., p. 12. (For the experiments, *see* Part VII., Cow 23).

‡ These results were obtained from four only of the cows (*see* Table XVIII.).

TABLE XX.

86 SHOWING the CASES in which INOCULATION with MEAT gave POSITIVE, and FEEDING NEGATIVE, RESULTS.

Number of Cow.	Inoculation Experiments.		Feeding Experiments.	
	Number of Animals.	Number of Animals that developed Tuberculosis.	Number of Animals fed.	Number of Animals that developed Tuberculosis.
9.	1	1 Tub.	8	None.
6.	3	1 Tub.	6	None.
15.	3	1 Tub.	5	None.
22.	7	2 Tub.	7	None.
13.	2	2 Tub.	2	None.

With the results shown in this table may be compared those in which the inoculation experiments were negative and the feeding positive; these occurred only with the meat of cows with advanced and generalised tuberculosis.

TABLE XXI.

87 SHOWING the CASES where INOCULATION with MEAT gave NEGATIVE, and FEEDING POSITIVE, RESULTS.

Number of Cow.	Inoculation Experiments.		Feeding Experiments.	
	Number of Animals.	Number of Animals that developed Tuberculosis.	Number of Animals fed.	Number of Animals that developed Tuberculosis.
20.	1	None.	5	4 Tub.
21.	1	None.	6	2 Tub.

Attention may be drawn to the irregularity of these results. In a series of experiments (inoculation and feeding) with the meat, the tuberculous material present may be sufficient to give the disease by inoculation, but not by feeding, as in the case of meat from cows the subject of mild or moderate tuberculosis, but even in the case where the tuberculous material is in sufficient quantity to give the disease by feeding (as in the case of advanced or generalized tubercle in cows), a negative result may be obtained by inoculation.

The more closely the results are considered, the more does the irregularity of the infectivity of the meat appear. To make the matter clear, the subject will be considered under the headings of: (1) irregular character of the positive results from feeding; (2) irregular character of the positive results from inoculation.

88 (1.)—*Irregular character of the positive results from feeding with meat.*

On examining Table XVIII., on p. 28, it is seen that all the animals fed with the meat of cow No. 20 did not develop tuberculosis; four out of five showed the disease, and the animal that was not tuberculous was a guinea-pig, an animal very susceptible to acquiring the disease, whether by feeding or by inoculation. This anomaly is most marked in the experiments with the meat of cow No. 21, for of the guinea-pigs only one out of four developed tuberculosis, and of the pigs one out of two. These two pigs were in the same sty and fed out of the same trough, the feeding lasted three days, no other food being given; they were of the same litter, equal in size, and eat their food, as far as could be ascertained, equally. Yet one developed tuberculosis, the other not. The meat of cow No. 21 was not so infective as that of cow No. 20, and the fact that only one of the pigs fed with its meat developed tuberculosis may be explained by the consideration that this pig eat most of the parts of the meat containing tuberculous material, and that the other pig did not eat sufficient of the infective material to produce tuberculosis.

89 (2.)—*Irregular character of the positive results from inoculation experiments with meat or meat juice.*

In the case of some of the cows the meat of which was found infective, several animals were inoculated, some developed tuberculosis, some not. This statement applies to the experiments both with the meat juice and the meat itself. Thus, as will be seen from the following table (XXII.) in some cases not only was the meat juice infective while the meat from the same cow was innocuous, but that with one and the same specimen of juice, one animal developed tuberculosis, another not (Cow No. 6). This is a significant fact.

TABLE XXII.

90 SHOWING the IRREGULARITY of the RESULTS from INOCULATION with MEAT OR MEAT JUICE.

No. of Cow.	No. of Animals inoculated.	Meat or Meat Juice.	Result.	Trimmed or un-trimmed Meat (T. or un-T.).	Proportion of Animals that developed Tuberculosis.
6. *Mild Tuberculosis.*	1	Juice	Nil	T.	1 out of 3.
	2	Juice	1 Tub., 1 Nil	un-T.	
15. *Moderate Tuberculosis.*	1	Juice	Tub.	T.	1 out of 3.
	1	Meat	Nil	T.	
	1	Meat	Nil	un-T.	
22. *Generalised Tuberculosis.*	2	Meat	Nil	T.	2 out of 7.
	2	Juice	2 Tub.	T.	
	2	Meat	Nil	un-T.	
	1	Juice	Nil	un-T.	
23.	2	Meat	1 Tub., 1 Nil	T.	3 out of 4.
	2	Meat	2 Tub.	un-T.	

91 Another feature of the inoculation experiments with the meat or meat juice brings out the irregular nature of the infection more clearly. Of the 48 animals inoculated with the meat or meat juice of 20 cows, 10 developed tuberculosis, the material used for inoculation being derived from six of the cows. Two of the animals were inoculated only on one side beneath the skin, the remainder were inoculated on both sides. Of these latter, two animals developed tuberculosis on both sides, *i.e.*, the inoculation being made under the skin in the groin, the inguinal glands and lumbar glands of both sides became tuberculous, a general infection of the body ensuing. The course of tubercle from inoculation in the rabbit or guinea-pig has been already fully dealt with (Part I., p. 13). It is sufficient here to repeat that if tuberculous material is introduced under the skin of the rabbit or guinea-pig in each groin, the inguinal and lumbar glands on both sides become tuberculous. If the material to be tested is inoculated on both sides and the inguinal glands and lumbar glands of only one side become tuberculous, the material introduced on the other side must be considered as not infective. Now, in the performance of the inoculation experiments with meat the sterile jar containing it was opened and a small portion of the meat chosen at random was inoculated on both sides. With juice, the liquid that collected at the bottom of the jar in which the minced meat was kept was poured into a sterile vessel and used for inoculation in each groin. If the infective material were evenly distributed throughout the juice it would produce tuberculosis in both inguinal glands; but it is a remarkable fact that in two cases it did not do so. Similarly, if the infective material were uniformly distributed throughout the substance of the meat, tuberculosis would have developed on both sides, and not on one alone. These cases are set forth in the following list; in all, pieces of the rump, or the juice from the rump, were used for inoculation.

92 EVIDENCE of IRREGULARITY OF INFECTION from INOCULATION by MEAT.

Cows with Mild Tuberculosis.

Cow No. 6.—

One rabbit inoculated with meat juice, 1 cc. each groin: killed in 120 days.

P.M. exam.—*Right inguinal region:* normal.

Left inguinal region: a chain of caseous glands containing numerous T. bacilli. No tubercle elsewhere.

Cows with Moderate Tuberculosis.

Cow No. 9.—

One guinea-pig inoculated in each groin with meat: died in 62 days.

P.M. exam.—*Right inguinal region:* normal.
Left inguinal region: a scar $\frac{1}{8}$-inch diameter inside nipple surrounded by fibrous tissue and containing T. bacilli. Small sub-peritoneal abscess opposite the spleen containing T. bacilli. No tubercle elsewhere.

Cow No. 13.—

(*α*.) One rabbit inoculated with meat each groin: killed in 85 days.
P.M. exam.—*Left inguinal region:* slight hæmorrhage, no tubercle.
Right inguinal region: an abscess with caseous contents; caseating inguinal, lumbar, and cœliac glands; the lesions showing numerous tubercle bacilli. No tubercle in any of the other glands or organs of the body.

(*β*.) One rabbit inoculated with meat juice, 2 cc. each groin: killed in 66 days.
P.M. exam.—*Left inguinal region:* normal.
Right inguinal region: a caseous mass in the thigh muscles; on microscopical examination showing the structure of tuberculous nodules with numerous tubercle bacilli.

Cows with Advanced and Generalised Tuberculosis.

Cow No. 23.—

(*α*.) One guinea-pig inoculated with meat both sides: killed in 56 days.
P.M. exam.—*Left side:* normal.
Right side: caseous inguinal and lumbar glands, containing numerous tubercle bacilli. Tuberculosis of liver and spleen; none elsewhere.

(*β*.) One guinea-pig inoculated with meat both sides: killed in 56 days.
P.M. exam.—*Right side:* normal.
Left side: caseous inguinal and lumbar glands, containing numerous tubercle bacilli. Tuberculosis of the spleen, but of no other organs or glands.

The results show very clearly the irregular development of tuberculosis from meat inoculation.

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meat.

93 A question must now be considered which bears directly on the results of the experiments recorded above, this is the infective virulence of the meat, whether given as food or used for inoculation. In other words, the question is really one of the degree of tuberculosis produced in the experimental animals by feeding and inoculating with meat. The degree of tuberculosis produced in an experimental animal depends on three conditions:—

1. The state of activity of the infective agent, the bacillus tuberculosis.
2. The quantity of the infective agent introduced into the animal.
3. The degree of susceptibility of the animal to the disease.

94 The third condition may be dismissed with a few words; the animals used for experiment were susceptible to the disease, guinea-pigs and rabbits being highly so, pigs, perhaps, to a less extent. With regard to the second point, the greater the amount of infective material given to the animal, the greater the extent of the tuberculosis subsequently developing, *i.e.*, not only are the tuberculous lesions well-marked, but the disease spreads more rapidly to the glands and organs of the body. A very small dose might, therefore, possibly produce a purely local disease, without general affection of the organs of the body. This consideration must, however, be taken with the question of the activity of the infective agent, because if the activity were diminished the tuberculosis resulting from inoculation or feeding by any constant amount would be less than if the activity were great; and *vice versâ*. As regards cultivations of the tubercle bacillus in the laboratory, it is known that they become less virulent after a time, but in tuberculosis as it occurs in animals and men, it is difficult to gauge the state of virulence of the bacillus. The virulence of a tuberculous lesion may be estimated to some extent by the number of bacilli present in it, and material taken from any, even a chronic, caseous tuberculous lesion in a cow will give well-marked tuberculosis to guinea-pigs by feeding or inoculation (*see* experiments in feeding with "grapes," Part IX.). It does not appear, therefore, that the question of activity of the infective agent is of much moment in these experiments with the meat; it appears more probably a mere question of dosage, *i.e.*, of the amount of tuberculous material present with the meat.

Evidence that meat when infective does not contain a large amount of tuberculous material.
1. From inoculation experiments.

95 The degree of tuberculosis produced by the inoculation of rodents with virulent tuberculous material has already been discussed in Part I. of this report. Suffice it here to repeat that in about two months from inoculation all the internal lymphatic glands and organs of the body become affected with tuberculosis. The degree of tuberculosis present in an animal at this period or beyond is therefore some test of the virulence of the material inoculated.

96 In the experiments with the meat, it is quite evident that the material was not in most instances of a highly infective nature. Since although in cases of mild and moderate tuberculosis positive results were in some cases obtained from inoculation with the meat, feeding experiments with meat from these cases were uniformly negative.

97 There were, as stated above, 10 inoculations with meat or meat juice which produced tuberculosis; of these one will be excluded from the present consideration, as it lived only 16 days. The remaining nine animals lived 56 days or longer, up to 120 days. Of these, three showed local tuberculosis following inoculation.

(1.) One rabbit (cow No. 6, mild tuberculosis), inoculated with 1 cc. of meat juice in each groin, was killed in 120 days; and tuberculosis of the inguinal glands on one side only was found; tubercle bacilli being present. None of the internal organs were affected.

(2.) One guinea-pig (cow No. 9, moderate tuberculosis), inoculated with meat in each groin, died in 62 days; a small tubercular scar was found in one groin and a small tubercular sub-peritoneal abscess, both lesions showing tubercle bacilli. None of the internal glands or organs were affected.

(3.) A rabbit (cow No. 13, moderate tuberculosis), inoculated with 2 cc. of meat juice in each groin, died in 66 days; a small tubercular caseous mass containing numerous tubercle bacilli was found in the right thigh. None of the internal organs or glands being affected.

These three cases are very clear examples that localised tuberculosis may be produced by meat or meat juice inoculation. All the other cases were not, however, of this description; to a less extent, however, they show that tuberculosis was slow in progress after inoculation with the meat.

98 A. Thus, in two animals the tuberculosis had spread in 56 days only to the glands and organs of the abdomen:—

α. One guinea-pig (cow No. 23, generalised tuberculosis), inoculated with meat in each groin, was killed in 56 days, and tuberculosis of the right inguinal and lumbar glands, of the cœliac glands and of the liver and spleen, was found, but of no other organs or glands. The lesions showed tubercle bacilli.

β. One guinea-pig (cow No. 23, generalised tuberculosis), inoculated like the first, was killed in 56 days; tuberculosis of the left inguinal and lumbar, of the cœliac glands, and of the spleen was found, but of no other organs or glands. The lesions contained tubercle bacilli.

99 B. In four animals the tuberculosis had spread in 52 to 85 days to the glands or organs in the thorax, in all cases tubercle bacilli being found in the lesions.

α. One guinea-pig (cow No. 22, generalised tuberculosis), inoculated with 2 cc. of meat juice in each groin, died in 52 days; tuberculosis of both sets of inguinal and lumbar glands, of the cœliac, mesenteric, bronchial, and mediastinal glands, of the spleen and liver, but not of the lungs was found.

β. One guinea-pig (cow No. 23, generalised tuberculosis), inoculated with meat on both sides, was killed in 56 days; tuberculosis was found in both inguinal and lumbar glands, in the cœliac, and in the anterior mediastinal glands, in the liver and spleen, but nowhere else.

γ. One guinea-pig (cow No. 15, moderate tuberculosis), inoculated with meat juice (1 cc.) in the right groin, was killed in 79 days; it showed tuberculosis of the right inguinal and lumbar glands, of the cœliac, posterior mediastinal, and bronchial glands, and of the lungs.

δ. One rabbit (cow No. 13, moderate tuberculosis), inoculated with meat in each groin, was killed in 85 days, and showed tuberculosis of the right inguinal and lumbar glands, of the cœliac, mediastinal, and bronchial glands, of the liver, spleen, and lungs.

It is evident from the foregoing experiments that:—

(1.) The inoculation of meat or meat juice from cows the subject of mild or moderate tuberculosis may produce only a local tuberculosis, though the animal lives over 56 days after inoculation.

(2.) Tuberculosis produced by the inoculation of meat or meat juice from cows the subject of moderate or advanced and generalized tuberculosis may, however, spread into the internal organs of the organs, although its march is slower than when obvious tuberculous material is inoculated.

(3.) That in one cow (cow No. 13, moderate tuberculosis) the meat juice produced in one inoculation a local tuberculosis of one side; the meat, in another inoculation, a general tuberculosis spreading from the inguinal glands of one side.

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eriments.

100 The three guinea-pigs that developed tuberculosis from feeding with meat, did not show any variation from the natural course of tuberculosis in guinea-pigs by feeding with tuberculous material, as regards the number of organs affected at the time of death.

Three pigs developed tuberculosis from meat feeding, and they all showed one point in common, viz., the absence of any local tubercular lesion of the alimentary tract. This may be taken as a sign that the meat did not contain a large amount of tubercular material (*see* Part I. of this Report, p. 16).

Results and Conclusions.

101 Although in a small proportion of the cases of mild and moderate tuberculosis—in three cows out of 16—the inoculation of the meat produced tuberculosis, showing that tuberculous material was in some of these cases present with the meat, it is quite evident from the experiments just reviewed that the meat from cows suffering from a mild or a moderate degree of tuberculosis does not give tuberculosis to animals by feeding. The inquiry which was entrusted to me was not solely the scientific investigation as to whether the muscular tissue of a cow the subject of tuberculosis, was infective, but whether the meat of the carcase as flayed and dressed by the butcher possessed infective properties. Had it been required to investigate only the infectivity of muscular tissue, it would have been sufficient for the correct carrying out of the research to have removed portions of the substance of the muscle some distance from the surface with sterile instruments; only these portions being used for experiment. An investigation carried out in this manner would not, however, have settled the practical question as to whether the meat of the carcase of a tuberculous cow as prepared for sale possesses infective properties; for the preparation of the carcase introduces a danger of infection from the tuberculous lesions present in the slaughtered animal. That this may be a source of contamination must be evident to anyone who has engaged in experimental research in pathology; and to have limited this inquiry to the mere testing of the infectivity of portions of muscle removed antiseptically would have been to disregard the practical aspect of the subject to be investigated; the question being whether the meat of a tuberculous cow as prepared for sale by the butcher is capable of transmitting tuberculosis. Portions of meat removed in the manner previously described, with knives not obviously smeared with tuberculous material but still not sterilized, must be considered as possibly possessing two sources of infectivity:—

(1.) The muscular tissue itself may contain infective material.

(2.) The infective material may be on the surface of the portions of meat removed, and would have been placed there by the knife used in excising them, by the butcher's hands or cloth, or by the contact with tuberculous organs during their removal: or it might be conveyed by the butcher's knife or cloth from a tuberculous carcase to a healthy one.

102 It was thought that "trimming" the cut surfaces of the pieces of meat as in the manner already described would in great part remove any accidental contamination of the meat which had occurred during its removal from the carcase; and throughout the investigation the experiments were performed with trimmed and untrimmed meat in order to compare the results in each. But in summing up the results after a microscopical diagnosis of the lesions in the experimental animals had been made, it was clear that the division of meat into these two classes was not of great practical importance. The feeding experiments are from this point of view of chief interest. In not one of the 16 cows the subject of a mild or moderate degree of tuberculosis did the meat, either trimmed or untrimmed, prove infective when animals were fed with it, and it is evident from an inspection of Tables XVI. and XVII. that the amount of meat given was a sufficiently accurate test of infectivity. Positive results from feeding were obtained only from the meat of cows the subject of advanced and generalised tuberculosis; in two out of the four cows used the meat gave the disease to the animals fed, and in both these instances the meat was untrimmed.

103 Although the meat from cows the subject of mild or moderate tuberculosis did not produce tuberculosis in animals by feeding, yet in some of the inoculation experiments positive results were obtained. Thus:—

(1.) With the meat or meat-juice of eight cows (mild tuberculosis), 19 animals were inoculated, one developing tubercle from untrimmed meat.

(2.) With the meat juice of eight cows (moderate tuberculosis), 16 animals were inoculated, four developing tubercle, two from trimmed and two from untrimmed.

The reason of these positive results from inoculation have to be explained.

One fact is clear, viz., that the infective material was not evenly distributed with the meat. If it had been in all parts of the meat not only would positive results have been obtained by feeding experiments, but all the inoculation experiments with the meat of the cows that gave *some* positive results would have been positive. Attention has already been drawn to the irregularity of the results.

104 It may also be pointed out that the infective properties of the meat (what little there is of it) increases with the degree of tuberculosis of the cow. Thus:—

Of eight cows (mild tuberculosis), the meat of *one* gave positive results in one animal from inoculation: none by feeding.

Of eight cows (moderate tuberculosis), the meat of *three* gave positive results in four animals from inoculation: none by feeding.

Of five cows (generalised tuberculosis), four gave positive results either by inoculation or by feeding.

Moreover, the inoculation of the meat from the cows with mild or moderate tuberculosis produced in three out of the five experimental animals only a localised tuberculosis (p. 30), while in the case of the cows with advanced and generalised tuberculosis the meat produced on inoculation a tuberculosis spreading into the glands and organs of the body.

The question must now be discussed whether these positive results are due to the infective properties of the muscle itself or to accidental contamination of the meat before or during its removal from the carcase by the butcher.

105 1. Is the muscular tissue of a tuberculous cow infective?

It must be remembered that tuberculosis is not a disease in which the infective agent (the bacillus tuberculosis) is present in all parts of an animal the subject of the disorder, but one in which the bacillus grows and flourishes in different lesions, at first microscopic, then visible to the naked eye as minute semi-transparent nodules, becoming, as they grow, yellow and caseated. The tubercle bacillus does not grow and flourish in the blood; although it may in rare instances be carried by the blood-current and so infect organs in which it is lodged. It is not surprising, therefore, to find that nearly all the experiments, performed with proper precautions, to test whether the blood of a tuberculous animal is infective, have proved negative. Moreover, when injected into the circulation of an animal the tubercle bacillus soon disappears from the blood.

The positive results obtained from the experiments with the meat cannot, therefore, be ascribed to the presence of the bacilli in the blood of the muscular tissue.

In the next place were these results due to the presence of tuberculous lesions in the muscle? These lesions are rare, but there is no doubt that if present, that particular part of the muscle in which they are present must be considered as infective.

Of the 21 carcases examined, only two showed tuberculous lesions in the muscle; in one of these the tubercles were visible to the naked eye, in the other only detected by the microscope. In the first case, occurring in Cow 9, there is no doubt that the lesions were tubercular, although no tubercle bacilli were found in the microscopal preparations. The experiments performed with the meat were as follows :—

106 *Cow* 9 (moderate tuberculosis). From part ofthe rump containing no visible tubercle a guinea-pig was inoculated. A local tuberculosis was developed as has been already fully described. Feeding experiments were made with three separate lots of guinea-pigs with the rump *without* visible tubercle, with the rump *with* visible tubercle, and with the intercostal muscles and the diaphragm. Not one of the animals developed tuberculosis (Table XVII.).

In this instance, therefore, the presence of caseous tuberculous lesions in the meat did not impart any great infective property to it, chiefly because, no doubt, these lesions were insignificant in extent.

The second case, that of Cow 12 (moderate tuberculosis), is, perhaps, even of more interest than that just discussed. In the muscles of the rump of this cow there was no visible tubercle, but in the nine microscopical sections of the meat a solitary quite recent miliary tubercle was found with a single tubercle bacillus (*see* Plate I.). This was a lesion which could not be seen with the naked eye, and its presence might be considered as an indication that the meat was of great infectivity. But the two inoculation experiments were negative. and the feeding experiments showed most conclusively that there were not many miliary tubercles in the meat, as none of the experimental animals developed tuberculosis, even though one rabbit was fed with 900 grammes of the meat, four guinea-pigs with 1,160 grammes, and one pig with 6,110 grammes (Table XVII.). This solitary miliary tubercle was not, therefore, an indication that the meat was infective; it was an exceptional occurrence; the miliary tubercles were not numerous in the meat, for, if they had been, some at least of the animals inoculated or fed would have developed the disease.

107 But in this particular instance, although the meat, containing as it did a tuberculous lesion, was not found infective, yet the question arises as to whether the finding of this miliary tubercle may not serve to indicate the explanation of the cases of tuberculosis produced by the inoculation of meat or meat-juice.

The experiments which have been recorded do not afford a direct answer to this question, but, for all practical purposes, it can be answered indirectly by inference from the results obtained. Thus in the large number of microscopical sections of the meat of 18 cows (in 7 of which the meat was infective), not a trace of a tubercular lesion could be discovered, and in numerous preparations of the expressed muscle-juice of five of the animals no tubercle bacilli were found. Miliary tubercle of the muscles was, therefore, not present to any great extent, if at all, in these 18 cows. No naked eye tubercle was present. It might, of course, be said that the microscopical sections made which are infinitesimally small compared to the bulk of muscles of the carcase, might not have been made through the miliary tubercles, even if they were present. Still the more sections made and the more carcases examined the less likely would the condition be missed if it were there. Taken in connexion with the fact that in all cases of mild or moderate tuberculosis in cows the meat gave no positive results on feeding, the microscopical examination justifies the inference that miliary tuberculosis of the muscles is an exceedingly rare event in tuberculous cows.

108 The positive results of the inoculation by meat might possibly be explained by the presence of miliary tubercle in muscle; on the supposition that this happened to be present in the small portions of meat or in the meat juice which gave the positive results. But this is not the explanation that agrees best with a critical survey of the investigation. Not only was miliary tubercle not found in the muscle in any of the cases which gave positive results, but the meat which gave the positive results by inoculation gave negative by feeding. Moreover attention has been drawn to the fact (p. 31) that the infective properties of the meat increase with the degree of tuberculosis of the cow. It might fairly be said this might be so, and yet the infectivity be due to miliary tubercle found in the muscle, since the more advanced the tuberculosis of the animal the more likely would the muscle become affected. But even supposing that this hypothetical miliary tubercle existed, with the increase of tuberculosis of the cow another danger increases in far greater proportion, and that is the danger of contamination of the meat by the tubercular lesions of the cow during the flaying and dressing of the carcase. The greater the amount of tubercle there is in the cow the more likely is the sticky caseous matter to get smeared over the carcase. I therefore think that in the absence of clear proof of tubercular lesions in the muscle this accidental contamination of the meat appears to explain all the positive cases of tuberculosis obtained in these experiments by inoculation or feeding with the meat of tuberculous cows. My reasons for this opinion may be summarised as follows :—

109 In the first place there is the fact that very few positive results were obtained at all. This would be so, because care was taken that no obvious tubercular material touched the meat.

2. The results are extremely irregular. With mild tuberculosis, only one inoculation was positive; none of the feeding experiments produced the disease. With moderate tuberculosis, four inoculations (from three cows) were positive; all the feeding experiments were negative.

3. The inoculations with the meat from a single cow were not all positive, even when one was so; and in three instances a local tuberculosis was produced, a remarkable event in a rabbit or guinea-pig.

4. Although in the majority of instances both trimmed and untrimmed meat gave by feeding negative results, yet positive results were obtained only with untrimmed meat. Owing to the very few positive results obtained by feeding, this point is not, however, of much importance.

110 If we imagine that the meat gets contaminated accidentally in this way, it is easy to explain the irregularity of the results:—(1) how, for example, in cases of mild tuberculosis of the cow, the danger of contamination is not great, and therefore the meat does not get smeared to any extent during removal; so that no positive results were obtained by feeding, and only one positive result by inoculation, and this a case of local tuberculosis, showing a small dose; (2) how, in cases of moderate tuberculosis where chiefly the lungs and lymphatic glands in the thorax are affected (and so may be removed entire without incision of a tuberculous lesion), the meat, as in cases of mild tuberculosis, would not become much contaminated and thus does not produce tuberculosis by feeding; and how in these cases the knife is more likely, accidentally or otherwise, to incise a tuberculous lesion than in cases of mild tuberculosis, and that therefore the number of cases of positive inoculation is greater. On similar grounds it may be understood why this contamination of the meat is not equally distributed; two inoculations producing local tuberculosis, and two inoculations with material from the same cow (Cow 13) producing, one a local tuberculosis, the other a generalised disease.

111 The question has been discussed in the preceding paragraph in relation to mild and moderate tuberculosis on the basis of the experimental results set forth in Tables XVI. and XVII. With generalised tuberculosis of the cow, this danger would increase, since so many parts of the body are affected with the disease; so that in such cases we meet for the first time with positive results by feeding; but not uniformly positive. In one case (Cow 20), for example, four out of five animals fed became tuberculous; but in the other (Cow 21) only two out of six. Here, again, it is clear that the animals that became tuberculous had eaten the part of the meat that had been smeared with tuberculous material. In these cases of generalised tuberculosis of the cow the irregularity of the results from inoculation are very evident. In Cow 22, for example, four meat inoculations were negative, two meat-juice were positive, and one was negative; while feeding gave no result.

112 Taking all the results together, the method of removal of the meat, the results of inoculation and of feeding, one is driven to the conclusion that when meat is infective it commonly acquires its properties by being accidentally contaminated with tuberculous material during its removal from the carcase. This conclusion, it is evident, is one of great practical importance, bearing directly on the question of the condemnation of the meat of tuberculous cattle for human consumption. And it is evident, also, that the infective properties of meat might vary with different series of experiments; that, for example, experiments performed in the manner described might give the results recorded, while other series of experiments performed by other observers might in some cases give negative results, and in others a larger number of positive results than are recorded in the present report. The result depends on the care taken in guarding against contamination more than on anything else. The conclusion arrived at in part explains the extremely divergent results obtained by previous observers.

113 *On the question of the condemnation of the carcases of cows the subject of tuberculosis as unfit for human consumption.*

The decision of this question rests on considerations regarding three distinct points:—

1. The infectivity of the meat and its cause.
2. The relative frequence of tuberculosis of muscular tissue in cows, and its recognition.
3. The presence of tuberculous lesions in the carcase as exposed for sale.

1. The first point has been already fully discussed. The experiments showed conclusively that the meat of itself did not give tuberculosis to animals by feeding if the tuberculosis of the cow were of a mild type, or of a moderate degree of extent, and that the few positive results obtained from inoculating the meat were in all probability the result of contamination during the process of cutting it away from the carcase. But in the case of advanced and generalised tuberculosis of the cow this danger of contamination was so great that feeding with meat gave tuberculosis to animals. There can be no question, therefore, that the carcases of all such cows are unfit to expose for sale. This conclusion is not based on the fact that meat of such wasted carcases is an inferior article of food (with that question I am not here concerned), but on the fact that the carcase as sold is liable to be largely contaminated with tuberculous material.

114 The question, therefore, for decision is limited to cases of mild and moderate tuberculosis, and it is now necessary to consider what amount of contamination of the meat is likely to arise from such cases. The experiments have shown that very little contamination is liable to occur, so little that the meat produced by feeding no tuberculosis even in the susceptible guinea-pig. But other practical points may be raised. Thus it is evident that the least contamination of the meat occurs in those animals in which the tubercular lesions of the cow can be removed by the butcher without his cutting into them. This would be done, for example, in the following cases with mild tuberculosis (p. 23), Cow 3, in which the lymphatic glands of the thorax were involved; Cow 7, in which the same glands and the liver were affected; Cow 8, in which the intestines and mesenteric glands and the udder were involved. Also in the following cows with moderate tuberculosis: 11, 12, 13, and 16, all with advanced tuberculosis of the lungs and lymphatic glands in the thorax. The cases which specially require consideration are those in which the serous membranes (the pleura chiefly) or in which the lumbar and popliteal glands* are affected. Thus in Cows 1, 2, 4, 5, and 6, with mild tuberculosis, and Cows 14 and 13, with moderate tuberculosis, the pleura was involved. The question may thus be narrowed to the consideration as to whether the presence of well-marked tuberculosis of the pleura constitutes a *great* danger of contamination of the meat in cases of mild or moderate tuberculosis. Referring again to the experiments, the answer must be in the negative. And this is evidently so if only the layer of pleura covering the lungs were affected with tuberculosis, because it would be removed with the lungs. But another practical point arises, viz., whether there is a danger if the layer of pleura covering the inner aspects of the ribs is affected. It is clear that no obvious tuberculous lesion ought to be left in a carcase, even if it be allowed to pass inspection, and consequently if such a carcase were passed, the affected pleura would have to be stripped off the ribs. Would this process of stripping be liable to contaminate the meat? A partial answer is given by referring to the experiments. In Cow 1 (mild tuberculosis, Table XVI.) the disease was well marked in both layers of the pleura. Several ribs, with the diaphragm attached, were cut out, and without any precaution whatever (the method of the butcher being imitated as closely as possible), the affected pleura was stripped off with the fingers, and the intercostal muscles and diaphragm used for inoculating two guinea-pigs, and for feeding one rabbit; none of the animals developed tuberculosis. In Cow 19 (advanced tuberculosis, Table XVIII.), besides tuberculosis of other organs, both layers of the pleura were one mass of "grapes," which contained numerous tubercle bacilli, and were very infective to guinea-pigs by feeding (*see* Part IX.). The affected pleura was stripped off the ribs as in Cow 1, but in this case with great care, the membrane not being touched with the fingers, but only with sterile forceps, and great care being exercised that the "grapes" did not touch the underlying muscles. Two guinea-pigs were fed with the intercostal muscles and the diaphragm; neither became tuberculous. It is evident, therefore, that the act of stripping off the affected pleura does not necessarily lead to contamination of the underlying meat. In one case, Cow 20 (generalised tuberculosis, Table XVIII.), this part of the meat gave tuberculosis by feeding, but not by inoculation. This case, however, does not really come under the present consideration, because not only was it one of generalised tuberculosis, but the pleura was very slightly affected, only a few "grapes" being found at the lower part. It cannot be said, therefore, that the mere presence of grapes constitutes a great danger of contamination to the meat even if they are removed.

115 It has been said by some that, inasmuch as inoculation with the meat or meat-juice of tuberculous cows gives, in some instances, positive results, therefore the meat ought in all cases to be condemned, since it is clear that if inoculation gives positive results, feeding will do the same, it being only a question of dose. And this supposition has been carried so far that calculations have been made to show that, if one cubic centimeter of meat-juice produced tuberculosis in one guinea-pig, this amount of juice being equal to so much meat, therefore the whole carcase of that cow is capable of giving tuberculosis to so many thousand guinea-pigs *by feeding*. This calculation would be, perhaps, quite correct if the infective material were evenly distributed throughout the meat, but the experiments which have been recorded show not only that no deductions can be drawn as to the results from feeding by the positive results of inoculation in the case of meat from mild and moderate cases of the tuberculosis in this cow, and even from the generalised cases; but that the positive results of inoculation with meat from one cow form only a small proportion of the total number of experiments performed.

One point is clear in discussing this part of the subject, viz., that in all cases of generalised tuberculosis in cows, the carcase ought to be condemned, simply from the danger of contamination of the meat.

116 2. The second point for discussion is the relative frequence of tuberculosis of muscular tissue in cows and its recognition.

It is clear that no tubercular lesion ought to be present in the carcase if it is to be sold for consumption. But the diagnosis of tuberculosis of the meat from an examination of the carcase without cutting into the muscle is impossible, since tuberculosis of the meat may be present in both moderate and advanced cases of the disease in the cow. As to its relative frequence, it has been stated above that it is extremely rare; although in two out of the 21 cows examined by me it was present, in one visible to the naked eye, in one visible only under the microscope. Two cases of tuberculosis of meat out of 21 post-mortem examinations in cows is a large proportion. The cow which showed visible tubercle in the meat was injected with Koch's lymph some time* previous to slaughtering; the one that showed microscopic tubercle was injected two days before killing. It is now known that the injection of Koch's lymph in an animal the subject of tuberculosis may lead to the dissemination of the disease throughout the body in the form of a miliary tuberculosis. Whether in the two cows mentioned the disease of the muscle was to be ascribed to the previous inoculation of tuberculin it is very difficult to decide, especially as in one of the cows the miliary tubercle was found only two days after the injection.

Looking at the matter from the purely practical point of view, it might be asked, does tuberculosis of the muscle constitute so great a danger that its possible presence may be disregarded, and the condemnation of meat for consumption rest solely on the results of the examination of the degree of tuberculosis of the cow? Tubercle of muscle cannot be diagnosed unless the meat is cut into; this would spoil the carcase for sale. It has been seen that in the experiments with the meat containing tubercle, no positive results were obtained by feeding or inoculating with the meat of two of the cows; and only one positive with that from the other cow; all the feeding experiments being negative. Tuberculosis of the meat is also a local disease, not spreading throughout the muscle of the carcase. Although, therefore, when tuberculosis of the meat is recognised, that carcase ought to be condemned, and although the injection of Koch's lymph in a tuberculous cow sometime previous to slaughtering ought to ensure condemnation of the carcase for food, yet as a common factor in rendering meat infective, tuberculosis of the muscle may be disregarded.

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* The question of the lumbar and popliteal glands is discussed under the third heading (p. 34).

* The exact date cannot be determined; the cows were not injected by me.

117 3. The third question for discussion is the presence of tuberculous lesions in the carcase as exposed for sale.

In this case it is again well to insist on the fact that no tuberculous lesion ought to be present in the carcase when it is exposed for sale. It is therefore important to determine (1) what tuberculous lesions may be so left in the carcase, and (2) whether their presence indicates any particular degree of tuberculosis of the cow.

The organs and glands left in the dressed carcase, and which may be tuberculous, are the kidneys, the lumbar and popliteal lymphatic glands; the lumbar glands are sometimes removed, and the cervical usually. The question of the cervical glands may be dismissed at once. They are affected in some tuberculous cows, and the tuberculosis may be limited there, or it may be present elsewhere as well. In the former case condemnation of the carcase is not indicated.

118 1. The kidneys in the cows examined were affected only in the advanced and generalised cases of tuberculosis. Reasons have already been given for the unconditional condemnation of such carcases. Whether the kidneys are ever affected in moderate cases of tubercle I cannot say from my own experience, but if found so in a carcase it would be wiser to condemn the carcase as food.

119 2. The lumbar glands, as has been stated, are sometimes removed from the dressed carcase. If they are present, their condition is a valuable indication of the tendency to generalisation of the disease, and there is no doubt that all the carcases in which the lumbar glands are affected with tuberculosis ought to be condemned as food. From this point of view, therefore, the following cases examined would be condemned. In the cows classed as mild tuberculosis, Cows 4 and 6, in both of which the lumbar glands were affected as well as the pleura and the lymphatic glands in the thorax. Among cases of moderate tuberculosis, Cows 9 and 10, in both of which there was advanced tubercle of the lungs and lymphatic glands in the thorax, as well as tubercle of the lumbar glands. In the case of generalised tuberculosis, Cows 20, 21, and 22 would also be condemned.

120 3. The *popliteal glands* were found affected in only one case out of 19 cows (Cow 10), and this was a remarkable case, inasmuch as, although the chief seats of the disease were in the lungs and in the lymphatic glands of the thorax, yet dissemination of the disease occurred through the lumbar and pelvic glands, the popliteal glands being also affected. It is an indication, therefore, that when the popliteal glands are tuberculous, the glands of the loin and pelvis are also affected. Such carcases ought to be rigidly condemned.

121 It must be assumed that this process of condemnation is dependent on a proper examination of the tuberculous animal, and that no such examination can be effectual unless the lungs, at least, are left to be examined. It is useful to see how many of the animals examined would be condemned as dangerous for food if such an examination were made.

1. Animals with advanced and generalised tuberculosis would be condemned from the danger of contamination of the meat with tuberculous material.

2. Animals would be condemned in which tuberculosis of the thoracic organs was associated with disease of the abdominal organs, or in which tuberculosis of the abdominal organs was associated with disease of the lungs and thoracic glands.

3. Similarly, all animals with tuberculosis of the lumbar or popliteal glands or of the kidneys would be condemned, since these lesions are a sign of generalisation of the disease.

4. Cases only of tuberculosis limited to one body cavity ought to be passed, *e.g.*, those in which the pleura, lungs, or thoracic glands alone, or those in which the intestines, mesenteric glands, liver, and udder alone, are affected.

122 A great difficulty will arise in those cases in which local tuberculosis of the parietal pleura is present. In these it is evident that, if passed, the parietal pleura must be stripped off, as no diseased part must be sent into consumption. Although the meat, as has been shown, may not be contaminated by the stripping off of the pleura the carcase is damaged, and ought to be condemned as such.

Putting these cases aside, it will be seen that out of the 21 carcases examined, five would be condemned as the subject of advanced and generalised tuberculosis, two out of eight of mild tuberculosis would be condemned in respect of disease of the lumbar glands, and two of moderate tuberculosis for the same reason, although the meat in the last four cases was found innocuous in feeding experiments. Nine out of the 21 cases would, therefore, be condemned.

123 As a corollary to the considerations stated above, there is no doubt that, whether a carcase be allowed to be passed for human consumption or not, in every instance tuberculous organs ought to be placed in a separate receptacle and burnt, and this ought to be done with all the internal organs of tuberculous cattle, whether affected with the disease or not.

INQUIRY II.

As to Food of Tubercular Origin: Its Infectivity to Lower Animals.

Part III.

Reports on the Experiments with the Milk of Tuberculous Cows.

Object of the Investigation.

124 To test whether the milk of tuberculous cows was capable of giving the disease by feeding or inoculating animals with it.

The milch cows were divided into four classes:—

1. Cows the subject of tuberculosis of the internal organs, in the various stages of mild, moderate, and advanced and generalized tuberculosis, but without tubercular or other disease of the udder. The milk of eight such cows was used for experiment.
2. Cows the subject of tuberculosis of the internal organs, and with tubercular disease of the udder. The milk of five such cows was used for experiment.
3. Cows the subject of tuberculosis of the internal organs, and with non-tubercular disease of the udder. The milk of two such cows was examined.
4. The milk of two other cows was used for experiment; in both animals there was no tuberculosis of the internal organs, but there was a chronic non-tubercular disease of the udder.

Method of Procedure.

125 All the cows were purchased by the Commission, and, with the exception of one which was under Dr. Woodhead's care at Balham, they were kept at Harrow. The sheds were kept clean, and after being used for a cow each shed was cleaned out, thoroughly disinfected, and the walls limewashed. Great attention was paid to the animals as regards food, &c., and many of the cows improved visibly after their arrival.

The animals were milked, as a rule, twice daily, morning and evening, and each day before the morning milking the udder was washed clean with soap and water, and the attendant washed his hands. The milk was drawn into sterile pails or milk cans, and the greatest care was exercised in sterilising these vessels just before the milking and directly after they had been used. It sometimes happened that experiments were proceeding with several cows at the same time. In this case a separate milk can was set apart and labelled for each cow. Those cows which gave infective milk were not allowed to be milked by the attendant at Harrow, but were milked by Mr. Dudley Cooper, so that there should be no risk of the accidental conveying of infection to any of the experimental animals or the spilling of infective milk.

These precautions were very necessary, and the results of the experiments show that they were effectual, since one class of milk was found infective and the other classes uniformly innocuous.

The morning milk freshly drawn was at once used for experiment; if there was any surplus it was not kept until the next day. The evening milk was kept in the ice safe during the night, and in the morning was used for feeding pigs. Guinea-pigs and rabbits had only the freshly-drawn morning milk.

Examination of the Milk.

126 The daily amount of milk given by each cow was measured, and the milk was in most instances analysed as regards its specific gravity, and percentage of cream, lactose, ash, and total solids. Coverglass preparations was made of the milk and examined for tubercle bacilli. In most instances the milk was first centrifugalised for one to two hours, and the deposit, if any, examined. The results of these examinations are given afterwards.

127 *Experiments with the Milk.*

As the cows were kept under observation for a month or longer, a daily supply of milk was obtained for experiment. In the feeding experiments, the milk was mixed each day with the sterilised food of the animals, four guinea-pigs or one rabbit receiving 100–150 cc. of milk, and one pig receiving 2–5 litres daily. The experiments were continued for some time, so that in some cases a large amount of milk was taken by the experimental animals. In the inoculation experiments the syringe was first boiled for several minutes, and the milk injected in varying quantities under the skin of rabbits or guinea-pigs, or into the peritoneal cavity of the latter animals. As a rule, 1 cc. was injected under the skin of each thigh; in rabbits as much as 5 cc. was used, while 1 cc. was the amount usually injected into the peritoneal cavity.

128 1.—Results of the Investigation of the Milk of Cows the subject of Tuberculosis of the Internal Organs, but without Tuberculosis or other Disease of the Udder.

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e cows.

As in the report on the meat experiments, the cows are divided into three classes according to the degree of tuberculosis present, viz., mild, moderate, and advanced and generalized tuberculosis.

The milk of eight cows in all was used, and the animals are classed as follows:—

Mild tuberculosis:—1 cow (No. 7).

Moderate tuberculosis:—5 cows (Nos. 11, 12, 13, 15, 16).

Advanced and generalized tuberculosis:—2 cows (Nos. 22, 23).

The meat of all these animals was used for experiment, and as the degree of tuberculosis has been already fully considered in the report on the meat, no repetition is necessary (*see* Part II., p. 23); for the full post-mortem examinations of the animals (*see* Part V.).

The udder was examined during life and after death. With the exception of Cow 22 it was found quite normal. In this cow there was a small encapsuled tumour the size of a hazel-nut behind the right posterior quarter of the udder. Microscopically this was found to be a hyaline fibroma. In the post-mortem examination every part of each quarter of the udder was examined carefully with the naked eye for any signs of disease. In none of the cows were there any signs of tuberculosis; the gland was secreting milk in every part, the teats were normal, and the supra-mammary glands, which become tuberculous when the udder is the seat of the disease, were quite normal. An average of over 10 microscopical sections of each udder* was made, and on examination showed the normal structure of the gland.

It may, therefore, be taken as absolutely certain that in all these cows the udder was not only free from tuberculosis, but from other disease affecting the secretion of milk.

Amount of milk given by the cows.

129 The average daily amount of milk given by these cows is shown in the following table for each week.

TABLE XXIII.

Average Daily Quantity of Milk of Tuberculous Cows without Disease of the Udder.

No. of Cow.	1st Week.	2nd Week.	3rd Week.	4th Week.	Degree of Tuberculosis of Cow.
	cc.	cc.	cc.	cc.	
No. 7 - - -	587	640	443	—	Mild.
No .11 - -	6,400	6,300	5,407	4,470	Moderate.
No. 12 - - -	2,633	850	—	—	”
No. 13 - -	59	—	—	—	”
No. 15 - - -	2,900	2,653	946	—	”
No. 16 - -	4,012	3,844	4,220	4,073	”
No. 22 - - -	4,595	3,457	1,800	—	Advanced and generalized.
No. 23 - -	1,360	2,035	1,600	1,570	” ”

The average daily yield of milk by these cows was therefore greatly below what it ought to be, viz., about 15 litres daily. The explanation of the small yield of milk rests on the fact that such cows are not sold as long as there is a sufficient yield of milk, and it was found possible to purchase them only when their milk had greatly diminished in quantity. The amount of milk given, however, in no way affects the conclusions of the experiments as to its infectivity.

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ysis.

130 The following table shows the results of the analysis of the milk of these cows; the mixed milk from all four quarters of the udder being used.

TABLE XXIV.

Analysis of the Milk of Tuberculous Cows without Disease of the Udder.

No. of Cow.	Sp. Gr.	Total Solids.	Cream.	Lactose.	Ash.	Remarks.
		Grammes per Cent.	Vols. per Cent.	Grammes per Cent.	Grammes per Cent.	
1. *Mild Tuberculosis.*						
No. 7 - - -	1,034	12·6	12·5	4·66	0·95	Normal colour. Slightly alkaline. No deposit.
2. *Moderate Tuberculosis.*						
No. 11 - - -	1,027	12·3	9·5	3·97	0·70	Normal colour. Slightly alkaline. No deposit.
No. 12 - - -	1,031	17·25	25·0	3·80	0·90	Normal colour. Slightly alkaline. Whitish deposit. Coagulates well with rennet.
No. 13 - - -	—	10·90	16·6	0·48	0·90	Yellowish serous-looking milk. Large excess of albumen. Does not coagulate with rennet.
No. 15 - - -	1,028	11·76	8·5	4·10	0·78	Normal colour. No deposit. Slightly alkaline.
No. 16 - - -	1,025	13·74	10·0	4·20	0·72	Normal colour. Slightly alkaline. No deposit.
3. *Advanced and Generalized Tuberculosis.*						
No. 22 - - -	1,025	12·44	5·5	5·30	0·56	Rather watery looking. Slightly alkaline.
No. 23 - - -	1,031	21·65	57·5	2·14	1·09	Rich yellow milk. Slightly alkaline; clots slowly and imperfectly with rennet.

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* The specimens of the udder of one of the cows (No. 11) were, unfortunately, mislaid, so that no microscopical examination was made. The udder was, however, quite normal in every respect.

131 These analyses do not show any particular chemical characteristic of the milk of these tuberculous cows. The specific gravity was below the normal in four of the cows (Nos. 11, 15, 16, and 22); the total solids below the average (12 per cent.) in two cows (Nos. 13 and 15), greatly above in one (No. 23). A great variation is noticed in the amount of cream, viz., from 5·5 vols. per cent. to 57·5 vols. per cent. The lactose was greatly diminished in two cows (Nos. 13 and 23), while the salts were excessive in Cows 7, 12, 13, and 23. The only milks which evidently presented any great difference from the normal was that from Cows 13 and 23. The milk of Cow 13 contained a great excess of albumen, and did not coagulate with rennet, showing that the casein was practically absent from the milk. She was a cow aged seven years, which had had several calves, and the milk had been sold up to the time of arrival at Harrow. Cow 23 was a case of advanced tuberculosis, and had had her first calf about five months before her purchase by the Commission.

Microscopical examination of the milk.

132 The milk of only one of the cows showed any deposit on standing or centrifugalizing. This was Cow 12; 10 preparations of the deposit were stained for tubercle bacilli, but none were found. The result of the examination of the milk for tubercle bacilli is as follows:—

Cow 7.— 8 preparations stained; no tubercle bacilli.
„ 11.—20 „ „ „ „
„ 12.—22 „ „ „ „
„ 13.—10 „ „ „ „
„ 15.—20 „ „ „ „
„ 16.— 8 „ „ „ „
„ 22.—35 „ „ „ „
„ 23.—12 „ „ „ „

In none of the cases, therefore, of these cows in which there was no tuberculosis of the udder, were tubercle bacilli found on microscopical examination.

133 RESULTS OF THE EXPERIMENTS TO TEST THE INFECTIVITY BY INOCULATION AND FEEDING OF THE MILK OF COWS THE SUBJECT OF TUBERCULOSIS, BUT WITHOUT DISEASE OF THE UDDER (TUBERCULAR OR OTHERWISE).

The results are seen in the following table, which is drawn up on the same plan as the results of the experiments with the meat:—

TABLE XXV.

INOCULATION AND FEEDING EXPERIMENTS WITH THE MILK OF TUBERCULOUS COWS WITHOUT UDDER DISEASE.

No. of Cow. Parts affected with Tuberculosis.	Inoculation Experiments.			Feeding Experiments.			
						Results with the Animals that lived long enough for Tuberculosis to develop, *i.e.*, 28 Days from the first Feeding.	
	No. of Animals.	Amount of Milk injected into each animal.	Result.	No. of Animals used in each Experiment.	Amount of Milk given.	No. of Animals.	Result.
Mild Tuberculosis. **No. 7.** Liver, lymphatic glands in thorax, lungs.	2 guinea-pigs.	2 cc. subcutaneously.	Nil.	4 guinea-pigs. 4 guinea-pigs.	cc. 3,425 1,725	4 3	Nil. Nil.
Moderate Tuberculosis. **No. 11.** Lungs, lymphatic glands in thorax.	2 guinea-pigs. 1 rabbit.	2 cc. subcutaneously. 10 cc. subcutaneously.	Nil. Nil.	4 guinea-pigs. 1 rabbit.	4,950 6,450	3 1	Nil. Nil.
No. 12. Lungs, lymphatic glands in thorax.	2 guinea-pigs. 1 rabbit.	4 cc. subcutaneously. 10 cc. subcutaneously.	Nil. Nil.	4 guinea-pigs. 4 guinea-pigs. 1 rabbit. 1 pig.	1,270 1,270 1,290 7,660	1 3 1 1	Nil. Nil. Nil. Nil.
No. 13. Lungs, lymphatic glands in thorax.	2 guinea-pigs.	2 cc. subcutaneously.	Nil.	4 guinea-pigs.	484	2	Nil.
No. 15. Pleura, lungs, lymphatic glands in thorax.	2 guinea-pigs. 1 rabbit.	2 cc. subcutaneously. 10 cc. subcutaneously.	Nil. Nil.	4 guinea-pigs. 1 pig.	3,150 46,145	3 1	Nil. Nil.
No. 16. Lungs, intestines, mesenteric glands, and glands in thorax.	3 guinea-pigs. 1 guinea-pig.	2 cc. subcutaneously. 1 cc. intraperitoneally.	Nil. Nil.	4 guinea-pigs. 4 guinea-pigs. 1 pig.	4,300 4,200 159,900	4 3 1	Nil. Nil. Nil.
Advanced and Generalized Tuberculosis. **No. 22.** Pleura, peritoneum, lungs, intestines, thoracic and lumbar glands, kidneys, uterus.	2 guinea-pigs. 1 rabbit.	2 cc. subcutaneously. 10 cc. subcutaneously.	Nil. Nil.	4 guinea-pigs. 1 pig.	3,400 52,003	3 1	Nil. Nil.
No. 23. Pleura, peritoneum, lungs, intestines, thoracic glands, kidneys, axillary gland.	4 guinea-pigs. 4 guinea-pigs.	2 cc. subcutaneously. 1 cc. intraperitoneally.	Nil. Nil.	4 guinea-pigs. 4 guinea-pigs. 1 pig.	2,700 2,700 56,555	2 3 1	Nil. Nil. Nil.
General result. 8 cows.	**38 animals inoculated.**	—	**None developed tuberculosis.**	—	—	**41 animals fed.**	**None developed tuberculosis.**

134 The results from these experiments are perfectly clear.

With the milk of eight cows the subject of mild, moderate, or advanced and generalized tuberculosis, 28 animals were inoculated, and 41 animals fed; not one developed tuberculosis. The inoculation of milk, as will be seen when the next class of cows is considered, is a definite and certain test of the infectivity of milk. In the experiments shown in the table it is evident that the feeding experiments were a severe test of the infectivity of the milk. With the large amount given from day to day to the guinea-pigs, rabbits, or pigs, no disease developed; and it is quite clear that if 50 litres (87 pints) of milk, or 160 litres (280 pints) do not give tuberculosis to a pig fed with it, that milk is not infective. After performing experiments with the milk of the first seven cows, an animal was fortunately purchased, which showed the typical features of advanced and generalized tuberculosis (Cow 23). The milk from this cow was put to a very severe test, as is evident from an inspection of the table, but it was not found infective.

The conclusion is, therefore, that the milk of cows the subject of tuberculosis of whatever degree, is innocuous when the udder is not affected with the disease; and as a corollary to this, that with tuberculosis of the internal organs and a normal udder no tubercle bacilli are present in the milk.

2.—Results of the Investigation of the Milk of Cows the subject of Tuberculosis of the Internal Organs, and with Tuberculosis of the Udder.

135 The number of cows used for experiment was five (Nos. 8, 20, 21, 24, 25).

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With the exception of No. 8, all the cows were the subject of advanced and generalized tuberculosis. Cows 20 and 21 have already been conidered in the report on the meat experiments (Part II., p. 24).

Cow 24 showed slight tuberculosis of the peritoneum and of the lungs, and advanced disease of the uterus, suprarenal capsules, kidneys, and the bronchial, posterior mediastinal, cœliac, cæcal, mesenteric, pelvic, and lumbar glands.

Cow 25 showed tuberculosis of the pleura, lungs, liver, kidneys, uterus, intestines, and the anterior and posterior mediastinal, bronchial, cœliac, and mesenteric glands, as well as those in the lesser omentum.

Cow 8 was a mild case of tuberculosis affecting the intestines and mesenteric glands and those in the lesser omentum.

ndition of udder.

136 The condition of the udders of these animals is most important. It is perhaps necessary to say that the udder of the cow is composed of four quarters, which are distinct anatomically and functionally as regards the milk secretion, although the connexion by means of lymphatic vessels must be somewhat intimate. These quarters are called respectively right anterior (R.A. ¼), right posterior (R.P. ¼), left anterior (L.A. ¼), and left posterior (L.P. ¼). If the cow has been killed without being milked, it is easy to see what parts of the udder are functionally active, since milk exudes freely from those parts on cutting into the gland. The mammary ducts empty into a sinus which is continuous with the duct traversing the teat. Behind and above the udder there are lymphatic glands (supra-mammary) which are affected with tuberculosis when the udder is diseased, and this constitutes a sure indication, post-mortem, of tuberculous disease of the udder.

The following is a description of the udder in the cows under consideration :—

v No. 8.

137 Cow No. 8.—The left posterior teat had been amputated. Both left quarters were solid and fused together, and on section showed numerous sinuous cavities lined with caseous material, the intervening udder tissue being studded in parts with tubercles. Both right quarters were normal to the naked eye. There was a large abscess at the posterior part of the udder, but not in the udder itself. The supra-mammary glands on both sides were tubercular and matted together.

Microscopically.—No tubercle was found in the right quarters, but the left quarters showed in the udder tissue sparsely scattered miliary tubercles, not caseated; no tubercle bacilli were found. The small mammary ducts were greatly thickened, and contained caseous matter, some cells, and numerous tubercle bacilli. The case was thus one chiefly of tuberculosis of the mammary ducts, with slight tuberculosis of the secretory gland tissue.

Cow No. 24.

138 Cow No. 24.—Both right quarters were enlarged to about twice their natural size; they were very tough and showed no evident tuberculosis on section. The left quarters were perhaps slightly enlarged. The supra-mammary glands were normal on the left side, and enlarged and hard on the right.

Microscopically.—There were sparsely scattered caseating tubercles in the right quarters, with numerous tubercle bacilli; most of the udder tissue was normal. In the left quarters these tubercles were very sparsely scattered, and a few tubercle bacilli were found in them. The right supra-mammary glands showed sparsely scattered tubercles, with a few tubercle bacilli. This, like Cow No. 8, was an example of mild tuberculosis of the secretory gland tissue, but the mammary ducts were not affected as in that animal.

Cow No. 21.

139 Cow No. 21.—Both posterior quarters showed well-marked caseous tubercle, the left quarter being more diseased than the right, and showing some cavities near the teat, lined with caseous material. The two anterior quarters showed nothing abnormal to the naked eye.

Microscopically.—The two posterior quarters showed advanced caseous tubercle, with innumerable tubercle bacilli. The right anterior quarter showed no tubercle, while in the sections of the left anterior quarter there were very sparsely-scattered miliary tubercles, not caseating, and containing very few tubercle bacilli.

Cow No. 20.

140 Cow No. 20.—The right and left posterior quarters of the udder were greatly enlarged, and were occupied by a very tough mass of yellowish tubercle. The anterior quarters were normal in some parts, in others infiltrated with tubercle. There were no abscesses.

Microscopically.—In the posterior quarters all the normal structure of the udder was replaced by caseous tubercle containing very numerous tubercle bacilli. The small mammary ducts showed caseous tubercle of their walls, and contained numerous tubercle bacilli.

This was a case then of advanced tuberculosis of the secretory gland tissue and of the mammary ducts.

Cow No. 25.

141 Cow No. 25.—All quarters were enormously enlarged and hardened. The disease was most marked on the right side, which showed on section numerous nodules of tubercle breaking down and forming cavities. In the left quarters there were small caseous tubercles. The ducts and sinuses were normal. The supra-mammary glands were enlarged and showed calcareo-caseous tubercle.

Microscopically.—All quarters of the udder showed advanced caseous tubercle, with innumerable tubercle bacilli; a little gland tissue was seen in the left quarters but not in the right.

In all these cows, therefore, there was tuberculosis of the udder. In No. 8 two quarters were affected (one only of these giving milk). In No. 24 the two right quarters were affected, and the left to a much less extent. In No. 21 two quarters showed advanced tuberculosis, and a third a very early stage of the disease. In Nos. 20 and 25 all quarters were affected.

History of Cows.

142 The history of these cows, as far as could be ascertained, may be stated :—

Cow No. 8 was purchased by a dairyman in September 1891. She had recently calved, and had then an "uneven bag." She was in milk until purchased by the Commission in October 1892. The left posterior teat was amputated in April 1892 for "acute mammitis" of the corresponding quarter, and the abscesses found post-mortem were, no doubt, due to this operation, in which, besides amputation of the teat, a knife was thrust into the udder tissue. When the cow was under observation, therefore, she gave milk from only three quarters—the left anterior and the two right quarters.

Cow No. 20 was an adult pedigree cow from a large dairy. She had been in milk till not very long before purchase by the Commission.

With Cows Nos. 24, 21, and 25 no history could be obtained.

Amount of milk given.

143 The daily amount of milk given by all the cows was greatly deficient. Records were kept in the case of two of the cows (Nos. 8 and 25). On the arrival of No. 8, 2,210 cc. of milk was the daily amount given; in 25 days this had fallen to 500 cc. No. 25 gave on arrival 900 cc. of milk in the day; in 40 days this had fallen to 420 cc. a day. No. 20 gave a very small amount of milk.

The reason of the small amount of milk given by these cows while they were under observation is that they were kept in the dairies from which they came as long as they gave a fair amount of milk.

Examination of the milk.

144 The following table shows the results of the examination and analysis of the milk of these cows; mixed milk from all the quarters being used.

TABLE XXVI.*

ANALYSIS OF THE MILK OF TUBERCULOUS COWS WITH TUBERCULOUS DISEASE OF THE UDDER.

No. of Cow.	Sp. Gr.	Total Solids.	Cream.	Lactose.	Ash.	Remarks.
		Grammes per Cent.	Vols. per Cent.	Grammes per Cent.	Grammes per Cent.	
No. 8	1.028	12·30	6·5	4·5	0·80	Normal in colour. Rather thin. Alkaline. Clots imperfectly with rennet.
No. 24	—	—	14·6	—	—	Normal in appearance; faint bluish tinge.
No. 21	—	10·18	4·3†	—	0·87	Natural in appearance; rather yellowish. Alkaline (slightly).
No. 20	1,005	—	16·5‡	—	—	Yellow serous fluid, containing 6·748 g. albumen per cent. Alkaline.
No. 25	1,028	13·85	19‡	2·7	0·85	Does not clot with rennet. Slightly alkaline. Milk from R. quarters is thin, serous-looking, and gives a deposit. From left quarters more opaque, but thin.

* For the conclusions to be drawn from these analyses, *see* "Diagnosis of Tuberculosis of the Udder," p. 41.

† Two days later the cream was 13 vols. per cent.

‡ This "cream" was the material floating on the surface on allowing the milk to stand. It was not cream, but a mixture of fat and coagulum of casein.

Examination of the milk for tubercle bacilli.

145 In two of the cows (Nos. 20 and 25) tubercle bacilli were readily found, and in large numbers, by simply drying the milk on a coverglass and staining in the usual manner. In one cow (No. 21) the bacilli were found in the milk from one of the quarters (L.P.¼). In two cows (Nos. 8 and 24) no tubercle bacilli were found. In Cow No. 8, the milk was centrifugalised, and eight coverglass preparations were made of the milk at the bottom of the tube. In No. 24, 40 preparations were made, 10 of these being with centrifugalised milk. These two cases were those in which there was a less degree of tuberculosis of the udder than in the other cows; the milk also, as will be seen, was less virulent. There may therefore be tuberculosis of the udder and yet tubercle bacilli may not be found. It is quite probable, and indeed almost certain, that if more preparations were made of the centrifugalised milk, that tubercle bacilli would be found in every case of tuberculosis of the udder in which the milk was infective; but the less the disease of the udder, the greater the number of preparations that would have to be made to decide whether tubercle bacilli were absent or not (*see* "Diagnosis of Tuberculosis of the Udder," p. 41).

RESULTS OF THE EXPERIMENTS TO TEST THE INFECTIVITY BY INOCULATION AND FEEDING OF THE MILK OF COWS THE SUBJECT OF TUBERCULOSIS OF THE INTERNAL ORGANS AND OF THE UDDER.

146 In the following table, the cows are arranged according to the extent of disease of the udder: those with the least disease coming first. Inasmuch as the previously-recorded experiments show that when there is no tuberculosis of the udder, the milk is not infective, the degree of disease in the udder is the only point in the classification of the cows which need be considered.

147 TABLE XXVII.

No. of Cow and Extent of Tuberculosis of Udder.	INOCULATION EXPERIMENTS.			Milk from which Quarter.	FEEDING EXPERIMENTS.			
	No. of Animals.	Amount of Milk injected.	Result.		No. of Animals used in each Experiment.	Amount of Milk given.	Results with the Animals that lived long enough for Tuberculosis to develop, *i.e.*, 28 Days from the first Feeding. No. of Animals.	Results with the Animals that lived long enough for Tuberculosis to develop, *i.e.*, 28 Days from the first Feeding. Result.
No. 8. Left quarters affected; no milk from L.P. quarter; no tubercle bacilli found in milk.	4 guinea-pigs.	2 cc. subcutaneously.	**All tub.**	Three available quarters.	4 guinea-pigs.	1,900 cc.	3	**2 tub.**
					4 guinea-pigs.	1,900 cc.	4	**1 tub.**
					1 pig	12,060 cc.	1	**1 tub.**
	2 guinea-pigs.	2 cc. subcutaneously.	**All tub.**	L. A. quarter	4 guinea-pigs.	1,800 cc.	2	Nil.
No. 24. Right quarters; left very slightly; no tubercle bacilli found in milk.	1 guinea-pig.	2 cc. subcutaneously.	**Tub.**	All quarters	4 guinea-pigs.	1,380 cc.	2	Nil.
	1 rabbit	10 cc. subcutaneously.	**Tub.**					
No. 21. Both posterior quarters; L.A. quarter very slightly; tubercle bacilli in milk.	1 guinea-pig.	0·3 cc. subcutaneously.	**Tub.**	All quarters	4 guinea-pigs.	200 cc.	3	**3 tub.**
	1 guinea-pig.	1 cc. subcutaneously.	**Tub.**					
No. 20. All quarters affected; numerous tubercle bacilli in milk.	1 guinea-pig.	0·5 cc. + 1·5 cc. sterile milk subcutaneously.	**Tub.**	All quarters	4 guinea-pigs.	208 cc. + 3 times bulk of sterile milk.	3	**3 tub.**
	1 guinea-pig.	2 cc. intra-peritoneally.	**Tub.**		4 guinea-pigs.	610 cc.	4	**4 tub.**
No. 25. All quarters affected; numerous tubercle bacilli in milk.	5 guinea-pigs.	1 cc. intra-peritoneally.	**All tub.**	All quarters	4 guinea-pigs.	300 cc.	1	**1 tub.**
					4 guinea-pigs.	500 cc.	3	**3 tub.**
					1 rabbit	600 cc.	1	**1 tub.**
	2 guinea-pigs.	1 cc. intra-peritoneally.	**All tub.**	A 10 per cent. dilution of milk.				
	2 guinea-pigs.	1 cc. intra-peritoneally	**All tub.**	A 5 per cent. dilution of the milk.				
General result. 5 cows.	**21 animals inoculated.**	—	**All developed tuberculosis.**	—	—	—	**27 animals fed.**	**19 animals developed tuberculosis**

148 The conclusions from these experiments are:—

1. When the udder is the seat of tuberculosis, the milk is in all cases infective, even though no tubercle bacilli may be found in the milk.
2. In all cases the milk gave positive results from inoculation of small quantities subcutaneously or intra-peritoneally, even when the results of feeding experiments were not uniformly positive. The inoculation of milk becomes, therefore, a very delicate test of the infectivity of milk as regards tuberculosis.
3. In those cases in which tubercle bacilli were found in the milk (Cows Nos. 21, 20, and 25), the feeding experiments were uniformly positive, as well as the inoculation experiments. It is noticeable, too, that a small dose of the milk diluted four times gave tuberculosis to all the animals fed (Cow 20), and that a dose of even 0·05 to 0·1 cc. diluted with non-infective milk was sufficient to produce tuberculosis (Cow 25).
4. In those cases in which tubercle bacilli were not found in the milk (Cows Nos. 8 and 24), all the inoculation experiments were positive, but not all the feeding. Thus in Cow No. 8, of six animals inoculated, all developed tuberculosis; of 10 animals fed, four developed tuberculosis. In Cow No. 24, of two animals inoculated, both developed the disease; of two fed, neither showed tuberculosis. This cow was examined at the very earliest part of the investigation in 1891, before the methods of experimentation had fully developed, so that the feeding experiments are not sufficiently numerous to be conclusive. Still the milk was infective, as shown by the inoculation experiments, and even if further feeding experiments had proved the milk infective by means of the intestines, the milk would come into the same class as No. 8, in which some positive and some negative results were obtained by feeding.

nce of lk.

The milk of cows with tuberculosis of the udder possesses a virulence which can only be described as extraordinary. All the animals inoculated showed tuberculosis in its most rapid form, such as it is seen after inoculation with a recent tubercular lesion, and this was the case even with Cows Nos. 8 and 24, the milk of which gave irregular results with feeding, so that in one case (Cow No. 8) it was possible to diagnose as tuberculous a local lesion produced by milk injection even though the guinea-pig lived only nine days, tubercle bacilli being found in the thickened tissues at the seat of injection.

Experiments regarding the Infectivity of the Milk Products of the Milk of Cows with Tuberculosis of the Udder.

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149 Only a few experiments were performed on this point with the milk of Cow 25. This cow did not give sufficient milk to make butter, so it was mixed with the milk of a healthy cow in equal parts. The milk used to dilute the tuberculous milk was not infective. One cubic centimetre injected into the peritoneal cavity of a guinea-pig produced no tuberculosis or other disease. The cow was also examined and found perfectly healthy.

The butter was made in the usual way, a glass revolving churn being used. All vessels and pans, the skimmers, cream-basins, and churn utilized in making the butter were sterilized before use.

2,940 cc. of the milk of Cow No. 25, with an equal quantity of the healthy milk, yielded 120 grammes of butter. The butter was of fair appearance, whitish and firm, being, however, somewhat granular. It was washed in the churn with brine, and the buttermilk kept for experiment.

The skimmed milk, which consisted of equal parts of tuberculous milk and of normal milk, was also used for experiment. The results are given below:—

Cow 25:—

Butter.—One cubic centimetre of butter melted at 40° C. was injected into the peritoneal cavity of a guinea-pig. It produced well marked tuberculosis; tubercle bacilli in large numbers being found in the lesions.

Buttermilk.—One cubic centimetre of buttermilk injected into the peritoneal cavity of a guinea-pig produced well marked tuberculosis; numerous tubercle bacilli being found in the lesions.

Skimmed Milk.—A similar experiment with one cubic centimetre of skimmed milk produced tuberculosis; numerous tubercle bacilli being found in the lesions.

A rabbit fed with 1,000 cc. of skimmed milk developed well marked tuberculosis of the intestines, mesenteric and mediastinal glands, and lungs; the lesions containing numerous tubercle bacilli.

It is evident, therefore, that when the milk is infective the butter, buttermilk, and skimmed milk are also infective, even when diluted with healthy milk in the process of manufacture.

More extended experiments on this point were not considered necessary.

(3.) Results of the Investigation of the Milk of Cows the subject of Tuberculosis of the Internal Organs, and with Non-Tuberculous Disease of the Udder.

150 Two such cows were examined (Nos. 17 and 18). They were purchased, as they were evidently, from the symptoms, the subjects of tuberculosis, and possessed diseased udders. The disease of the udder proved, however, on examination of the milk (during life) and of the animal after death to be non-tuberculous.

Degree of tuberculosis in the cows.

Both cows were the subject of a moderate degree of tuberculosis (*see* Part V.). Cow No. 17 showed well marked disease of the lungs, and of the mediastinal and bronchial glands, to a less extent of the mesenteric glands, of the intestines (very slight), and of the pleura.

Cow No. 18 showed almost the same extent of disease, the same parts were affected as in Cow No. 17, but the mesenteric glands and the intestines were more affected.

Examination of the udder.

Cow No. 17.—During life the left posterior and the right anterior quarters of the udder were hard, but not nodular. At the post-mortem examination these quarters were uniformly hard, and showed no naked-eye tubercle; very little milk was present in the ducts of the right anterior quarter, and that in the ducts of the left posterior quarter was coagulated. To the naked eye the right posterior and the left anterior quarters of the udder were normal. *Microscopically*, the portion of the right posterior quarter which was examined was found normal, but the other quarters of the udder showed a round-celled interstitial infiltration with proliferation of the epithelium of the acini. These changes were very advanced in the left posterior quarter, in parts of which the acini of the gland were destroyed by the pressure of the interstitial fibro-cellular tissue. No tubercle was present.

Cow No. 18.—All the quarters of the udder were affected to a slight extent, the left posterior quarter showing the most advanced change. There was interstitial fibro-cellular infiltration in all the quarters, with proliferation of the epithelium of the acini in the two left quarters and in the right posterior quarter, while in the right anterior quarter the acini were normal.

Examination of the udder just after death showed that the left posterior quarter was hard, while the other quarters appeared normal. No tubercle was present in any of the quarters.

In both these cows, therefore, the change may be described as "inflammatory," interstitial mastitis being present but no abscess and no tuberculosis.

History of Cows.

Cow No. 17 had calved three weeks previous to purchase: no other history was obtainable. Cow No. 18 had calved six weeks before her purchase, and had since been regularly milked. Her illness was said to have been of only 14 days' duration.

Amount of milk given.

Cow No. 18 was sent in a moribund condition, and had to be slaughtered immediately, so that the amount of milk given could not be estimated. Cow No. 17 gave, on arrival, 8,000 cc. of milk daily, but seven days later it fell suddenly to 990 cc., then gradually increased to over 4,000 cc., *i.e.*, in 26 days after purchase.

Examination of milk.

Cow No. 18 was killed before sufficient milk was obtained for analysis.

From Table XXVIII. it is seen that the milk from the left anterior quarter of the udder of Cow 17 was the only one that approximated to the normal; the lactose was slightly deficient. The milk from the other quarters showed coagulation of the casein, a deficiency or absence of the cream, and a great deficiency in the amount of lactose. The difference in the composition of the milk from the right posterior quarter at two days' interval was remarkable. The first analysis showed a practically normal amount of lactose and a deficiency of cream; two days later the casein was coagulated, the cream absent, only a trace of lactose present. In the interval a

151 TABLE XXVIII.

ANALYSIS of the MILK of a TUBERCULOUS COW with INTERSTITIAL MASTITIS.

No. of Cow.	Specific Gravity.	Total Solids, Grammes per Cent.	Cream, Volume per Cent.	Lactose, Grammes per Cent.	Ash, Grammes per Cent.	Appearances, &c. of Milk.
No. 17. Milk from—						
(1.) Right posterior quarter.	—	—	6	4·66	—	Thin, but normal in appearance. No deposit. Clots normally with rennet.
Do. (two days later).	—	—	None	Trace	—	Deposit of clotted casein equal to two-thirds of milk. Alkaline. No clot with rennet.
(2.) Right anterior quarter.	—	—	40 (and clotted casein).	1·28	—	Slight deposit. Ropy mass on surface, consisting of fat and clotted casein. No clot at once with rennet; firm clot in 24 hours. Neutral.
(3.) Left posterior quarter.	—	—	None	0·965	—	Numerous coagula. Slight clot with rennet. Alkaline.
(4.) Left anterior quarter.	—	15·0	15	4·09	0·85	Normal in appearance. Clots normally with rennet.

cataclysm had occurred in the secretion of milk from this quarter; and although this quarter of the udder never regained its secreting power, yet the milk from all the quarters, which was diminished at the time the change occurred in the right posterior quarter, gradually increased in quantity to one half of the original amount of milk given by the cow.

Microscopical examination of the milk.

152 Microscopical preparations were made of the deposit of the milk (Cow No. 17) of the left posterior quarter, right anterior quarter, and right posterior quarter. They all showed numerous cells—mono- and polynuclear leucocytes, and large mononuclear gland-cells full of fat granules, especially in the deposit from the left posterior quarter. There was, moreover, a large amount of amorphous matter; but no definite tubercle bacilli, although one or two rods stained pink were at first mistaken for these. The deposit of the milk from the left posterior quarter shewed a few cocci, singly and in twos. The milk from the left anterior quarter was centrifugalised; there was no deposit, and no cells, tubercle bacilli, or other micro-organisms were seen on microscopical examination.

The milk from each of the quarters of the udder of Cow No. 18 was centrifugalised and examined microscopically. A few leucocytes were seen, and some bacteria, but no tubercle bacilli, although some bacteria stained a light pink were at first mistaken for these.

It may be stated that the examination for tubercle bacilli in the milk of these cows was extremely difficult owing to the coagulation of the casein that had taken place.

The following table shows the results of the inoculation and feeding experiments with the milk of these cows:—

153 TABLE XXIX.

INOCULATION and FEEDING EXPERIMENTS with the MILK of two TUBERCULOUS COWS with INTERSTITIAL MASTITIS.

No. of Cow.	Inoculation Experiments.			Milk, from which Quarter of Udder.	Feeding Experiments.			
							Result with the Animals that lived long enough for Tuberculosis to develop, *i.e.*, 28 Days from the First Feeding.	
	Number of Animals.	Amount of Milk injected into each.	Result.		Number of Animals used in each Experiment.	Amount of Milk given.	Number of Animals.	Result.
No. 17	2 guinea-pigs	1 cc. intra-peritoneally.	Nil.	L.P. quarter.	—	—	—	—
	2 guinea-pigs	1 cc. intra-peritoneally.	Nil.	R.A. quarter.	—	—	—	—
	2 guinea-pigs	1 cc. intra-peritoneally.	Nil.	R.P. quarter.	—	—	—	—
	2 guinea-pigs	1 cc. intra-peritoneally.	Nil.	L.A. quarter.	—	—	—	—
	—	—	—	All four quarters	4 guinea-pigs	2,350 cc.	2	Nil.
	—	—	—	All four quarters	1 pig	111,450 cc.	1	Nil.
No. 18	6 guinea-pigs	1 cc. intra-peritoneally.	Nil.	All four quarters	—	—	—	—
General Result. 2 cows.	**14 animals inoculated.**	—	**None developed tuberculosis.**	—	—	—	**3 animals fed.**	**None developed tuberculosis.**

From these observations it is quite evident:—

1. That a non-tuberculous disease of the udder may be present in a tuberculous animal, and be, by physical examination, indistinguishable from tuberculosis of the udder.
2. That the milk in such cases of disease is not infective as regards producing tuberculosis; and that as regards tuberculous infection such cows may be placed in the same category as those with tuberculosis of the internal organs, but without disease of the udder of whatever kind.

(4.) Results of the Investigation of the Milk of Cows the subject of Non-Tuberculous Disease of the Udder, and with no Internal Tuberculosis.

154 Two such cows were purchased (Nos. 26 and 27) on the supposition that the disease of the udder was tuberculosis. On post-mortem examination no tuberculosis was found in any part of the body. The account given of these animals will be very brief; the full details as to history, post-mortem examination, and the experiments with the milk being found in Parts V., VI., and VII. of the Report.

Cow 26 had a chronic interstitial mastitis affecting the whole of the left posterior quarter and of the adjoining part of the left anterior quarter; the microscopical examination showing the absence of tuberculosis. She had had two calves, the disease of the udder appearing after the birth of the second calf, which occurred about five months before her arrival at Harrow. During the time the cow was under observation (50 days) the left posterior quarter of the udder, which on arrival was enlarged and hard, perceptibly diminished in size, although the hardness remained; this does not occur with tuberculosis of the udder. The milk

(Part VI., p. 64), which was normal in colour, showed, on analysis, a diminution of cream in the milk from each quarter of the udder, and in the left posterior and left anterior quarters (those affected with disease) a diminution in the amount of lactose. The post-mortem examination of the cow revealed no disease of the internal organs.

Cow 27 was a finely developed animal, suffering from an inflammatory disease of the udder, affecting all the quarters except the left posterior. Microscopically no tuberculosis was found. The disease was six months' old. She had also a chronic non-tuberculous abscess beneath the diaphragm, and was, in fact, the subject of chronic pyæmia. The milk obtained from the affected quarters became ropy with liquor potassæ, and contained pus. At one time the milk from the right anterior quarter was almost pure pus, with a slight admixture of milk. Pus-cells and cocci were found microscopically. The analysis of the milk of the affected quarters showed an absence of cream and a great diminution in the amount of lactose. (Part VI., p. 65). The post-mortem examination revealed no tuberculosis of the internal organs.

155 The experiments with the milk of these two animals showed, as might be expected from the facts just stated, that it did not produce tuberculosis. With the milk of Cow 26, six guinea-pigs were inoculated with 2 cc. of milk subcutaneously, one with 1 cc. intraperitoneally, and one rabbit with 10 cc. subcutaneously. In two of the guinea-pigs the inoculation produced enlarged glands and cell-necrosis; but there was no tuberculosis. Two rabbits were fed each with 500 cc. of the milk; neither showed any lesion. With the milk of Cow 27, nine guinea-pigs were inoculated, each with 1 cc. of milk intra-peritoneally. Of three guinea-pigs, each inoculated with the milk from one of the affected quarters of the udder, two developed an abscess as the result of the injection, and one died of acute peritonitis, due to cocci. One month later the milk was not so virulent, as three animals inoculated at that time showed no lesion post-mortem. Three guinea-pigs inoculated with the milk of the unaffected quarter of the udder (L. P.¼.) developed no lesion. Many feeding experiments were done with the milk (for details, *see* Part VIII.). In only one was a lesion produced. Four guinea-pigs were fed with 2,100 cc. of milk; one that died on the sixteenth day showed foci of suppuration in the mesenteric glands, due to cocci; the rest of the animals showing no lesion.

The milk of Cow 27, therefore, although not tuberculous, was infective, since it produced suppuration both by inoculation and by feeding.

Conclusions from the Results of the Investigation of the Infectivity of the Milk of Cows the subject of Tuberculosis.

156 The milk of uberculous cows is obviously divisible into two classes: (1) that given by cows the subject of tuberculosis of the internal organs without tuberculous disease of the udder; (2) that given by cows the subject of tuberculosis of the internal organs and of the udder.

The experiments conclusively show that no degree of tuberculosis of the internal organs confers infectivity on the milk, provided that the udder is not tuberculous. It is evident that this conclusion agrees with what is known of tuberculosis as a disease. It is a disease characterised by local lesions produced by the bacillus tuberculosis, which is the infective agent. The parts of the body in which the bacillus does not grow are thus not capable of carrying infection. How, then, is it possible to suppose that the highly specialised mammary gland would "excrete," so to speak, this bacillus through its well-developed secreting layers of cells? The experiments show that the tubercle bacillus is not excreted in this way, for in no single instance did the milk of the cows under consideration give the disease to animals either by inoculation or by feeding. It must be emphasised that in this research a complete investigation, both naked eye and microscopical, was made of the udder of the cows, and the presence of tuberculosis of the gland definitely excluded.

157 When tuberculosis of the udder is present, the condition of things is quite different. The milk is in all cases infective. The tubercle-bacilli may be in such numbers that they are readily found on microscopical examination (as in Cows 21, 20, 25); or they may be so few that microscopical examination does not detect them, *i.e.*, an examination carried out within practical limits. But whether the bacillus tuberculosis is found in the milk or not, the milk is infective, giving uniformly positive results after inoculation, the bacillus being found in large numbers in the infected animals. Feeding experiments with the milk in which tubercle bacilli were found were uniformly positive (Cows 21, 20, 25); but with the milk in which they were not found (Cows 8, 24) some of the animals developed tuberculosis, some not. This only means that the animals that remained healthy did not receive a sufficiency of the infective material, which, as shown by the innoculation experiments, was present.

The question of the infectivity of milk and of meat are, therefore, quite different. In the case of the meat of tuberculous cows, it was seen that only a very small proportion of the inoculation experiments were positive, and all the feeding experiments with the meat of mild and moderate cases of tuberculosis were negative. In the case of milk from cows with tuberculosis of the udder, all the inoculation experiments were positive, and the greater proportion of feeding (19 out of 27 animals fed).

There is, therefore, only one conclusion to be drawn from these experiments, viz., that the milk of cows with tuberculosis of the udder ought not to be allowed to be consumed, and that such cows ought to be removed from all dairies and slaughtered. The question of the diagnosis of tuberculosis of the udder is, then, one of great importance, and it will now be discussed.

The Diagnosis of Tuberculosis of the Udder of the Cow.

158 Tuberculosis of the udder is associated with tuberculosis of the internal organs; it is never primary. The tuberculosis of the internal organs may be of very varying degree. As an example of a mild degree of internal tuberculosis with tuberculosis of the udder, Cow No. 8 may be instanced, in which there was tuberculosis of the intestines, mesenteric glands, and the glands in the lesser omentum, but of no other internal organ; as an example of advanced tuberculosis with similar disease of the udder, Cow No. 24 may be quoted, in which the following organs were affected with the disease: lungs, kidneys, suprarenal bodies, uterus, and all the lymphatic glands of the thorax and abdomen.

Tuberculosis of the udder may, therefore, exist with mild or advanced tuberculosis of the internal organs. The symptoms which, during life, this disease of the internal organs gives rise to are not an accurate indication that the disease of the udder is tuberculous. In the first place, there may be no symptoms at all. Thus Cow No. 8 was a well nourished animal, it had no rise of temperature (Part VI., p. 59), and in fact showed no signs of disease of the internal organs, yet the disease of the udder was tuberculous. In the second place, although there may be the signs of internal tuberculosis, such as chronic fever, wasting and cough, associated with disease of the udder, this disease may not be tuberculous at all (as in Cows Nos. 17 and 18).

Although, indeed, every cow the subject of tuberculosis must be considered as likely at any time to develop tuberculous disease of the udder, yet the diagnosis of the character of disease of the udder rests on a consideration of the condition of the udder itself, and of the milk, and not of any general signs of tuberculosis.

The subject is thus naturally divided into two parts:—

1. The history of the disease of the udder and the physical examination of the udder.
2. The examination of the milk as to the quantity given and its chemical constituents; the presence of tubercle bacilli in the milk, and the infectivity of the milk.

159 1.—*History of the Udder Disease and Physical Examination of the Udder.*

During the course of the investigation, nine cows with disease of the udder were purchased by the Commission; five of these were cases of tuberculosis of the udder, four were cases which will be classed as inflammatory. They were all purchased with the idea that the disease of the udder was tuberculosis, the diagnosis being made by a veterinary surgeon, and on the ground that the cow was tuberculous from the wasting and cough, or was probably tuberculous, and that the udder was diseased, and therefore tuberculous. Of the four cows in which the udder disease proved to be non-tuberculous, two (Nos. 17 and 18) showed tuberculosis of the internal organs, and two (Nos. 26 and 27) showed no tuberculosis anywhere, one of these latter (No. 27) having a sub-diaphragmatic abscess, the other, a thin cow, with first calf, showing no disease anywhere in the body, except the udder. If reliance be placed therefore on the general condition of the cow, and on the physical examination of the udder, an accurate diagnosis of tubercular disease of the udder is not possible.

Tuberculosis of the udder is a slow, painless growth. A disease of the udder, therefore, which is slow in development, taking weeks or months to affect a large portion of the udder, and occurring in a tuberculous animal, is in all probability tuberculosis. Anything more definite than this cannot be said. The condition of the udder described above as inflammatory, or interstitial mammitis, may last a long time, but it is in most cases closely associated with calving, as in Cow 26 and in Cow No. 18, possibly in Cow No. 27 and in Cow No. 17 (Part VI.).

Again, although tuberculosis of the udder is usually painless, the udder may be tender in milking, as it was in Cow No. 25.

The enlargement of the supra-mammary lymphatic glands is not a diagnostic sign of tuberculosis, since they may be enlarged in non-tuberculous disease of udder, as in Cow No. 17.

160 2.—*Examination of the Milk.*

The diagnosis of tuberculosis from a history of the disease, and from a physical examination, is therefore extremely uncertain. The result of the examination of the milk is more satisfactory.

The examination will be discussed under the following headings:—

- α. The daily quantity of milk given by cows with tuberculosis of the udder.
- β. The chemical and physical characteristics of the milk.
- γ. The examination of the milk for tubercle bacilli.
- δ. The results of inoculations of milk into animals.

161 α.—*The Daily Quantity of Milk given by the Cow.*

The milk, as explained on p. 37, was greatly deficient in quantity in the cows examined, and showed a gradual diminution during the period of observation. The average daily yield of milk by healthy and good milkers may be taken as 15 litres; the largest daily yield of milk by Cow No. 8, was 2210 cc., and by Cow No. 25, 900 cc. The fact of this great diminution of milk does not aid the diagnosis of tuberculous disease of the udder, since cows with disease of the internal organs alone show a very irregular yield of milk (Table XXIII., p. 35). Cows with non-tuberculous disease of the udder show the same (Cow No. 17, p. 38, and Cow No. 26, p. 64).

162 β.—*The Chemical and Physical Characteristics of the Milk.*

The milk from a tuberculous udder may be quite natural in appearance and slightly alkaline, as in Cows Nos. 8, 24, and 21; or it may be yellowish and serous in appearance with flocculi of coagulated casein floating in it (Cow No. 21), or it may be more or less normal in colour, but with coagula floating in it (as in Cow No. 25, *see* p. 38, Table XXVI.).

The chemical analysis of the milk may be practically normal (Cow 8, p. 38).

Two points regarding the milk are worthy of consideration:—

1. The amount and character of the casein and albumen present.
2. The amount of lactose in the milk.

1. The casein is deficient in the milk from tuberculous udders, and with advance of the disease the casein tends to coagulate in the milk ducts, and flocculi of coagulated casein, or stringy masses of the same, are present in the drawn milk. The presence of casein was tested for by adding a few drops of rennet to the warmed milk; normal milk coagulates in a few seconds. The following examples will illustrate the changes in the casein in the milk of these cows (*see* Table XXVI., p. 38). Cow No. 8 gave milk from only three quarters, one of which was tuberculous; the milk coagulated imperfectly with rennet (which had to be used in large quantity), and did not readily separate into clot and whey, as in normal milk. This imperfect clotting in all probability indicates a deficiency of casein.

Cow No. 25 showed advanced tuberculosis of all quarters of the udder; the milk did not clot with rennet, and contained, when drawn, stringy masses of coagulated casein.

Cow No. 20 was also a case of advanced tuberculosis of all quarters of the udder. The milk was like serum, containing a few flocculi of coagulated casein, and a large percentage of albumen, nearly 7 per cent. (the percentage of albumen in normal milk being about 1·26).

The effect on the casein, therefore, as the tuberculosis of the udder advances is that it first diminishes, then coagulates in the milk ducts or sinuses, and finally disappears, albumen taking its place.

These changes are, however, not characteristic of the milk from tuberculous udders. As a rule, in tuberculosis of the internal organs (p. 35, Table XXIV.), the milk coagulates normally with rennet; but in one case of advanced and generalised tuberculosis (Cow No. 23), the milk clotted slowly and imperfectly with rennet, and in a case of moderate tuberculosis (Cow No. 13), the milk was yellowish and serous-looking, giving no clot with rennet, and containing a large amount of albumen. When there is no disease of the udder, therefore, the milk may have the same characteristics as regards the casein as in tuberculous disease of the udder. Similarly, when there is non-tuberculous disease of the udder, the milk may present appearances similar to those described as in Cow No. 17 (Table XXVIII., p. 40).

2. The amount of lactose present in the milk diminishes as the disease advances (Table XXVI., p. 38, Cows Nos. 8 and 25). On referring, however, to the analysis of the milk given by the cows with tuberculosis of the internal organs only (Table XXIV., p. 35), it is seen that in the milk of four animals (Nos. 11, 12, 13, and 23) there was a well-marked deficiency in lactose and this is most marked when the udder is the seat of inflammatory disease, as in Cow No. 17 (Table XXVIII., p. 40), in which the milk showed a deficiency of lactose according to the stage of disease in the quarter of the udder from which it was drawn.

The changes in the amount of casein and lactose, and in the condition of solution of the casein observed in the milk of cows the subject of tuberculous disease of the udder are not, therefore, characteristic of the disease. They are observed also in non-tuberculous disease of the udder, and in some cases of general tuberculosis of the cow in which the udder is not the seat of disease. The changes are in part to be ascribed to a diminution of the secreting activity of the mammary gland, produced in the one case by a local and spreading disease of the gland, and in the other by a general wasting disease of the body, aided, perhaps, by other causes—near period of calving, character of food, pregnancy, &c.—which need not here be considered.

163 γ. *The Examination of the Milk for Tubercle Bacilli.*

If tubercle bacilli are found in the milk, a diagnosis is at once possible, since, as we have seen (p. 35, *et seq.*), they are absent in the milk of tuberculous cows in which the udder is not diseased. Therefore the presence of tubercle bacilli in the milk is a sure sign of tuberculosis of the udder.

In three out of the five cases of tuberculosis of the udder examined, tubercle baccili were readily found by drying a drop of the milk on a coverglass and staining for tubercle bacilli in the usual way. In all three cases (Cows Nos. 20, 21, 25) the bacilli were numerous. In the case of Cows Nos. 8 and 24 tubercle bacilli were not found. Cow No. 8 gave milk which was natural in appearance. The milk was centrifugalised, according to the recommendation of Professor Baug, of Copenhagen, in order that all solid particles, bacilli, or shreds of tissue and cells should collect at the bottom of the tube. There was no evident deposit on centrifugalising, so eight preparations were made of the lowest stratum of the milk. No bacilli were found. In Cow No. 24, 32 preparations of the freshly drawn milk were made, and 10 preparations of the centrifugalised milk; but no tubercle bacilli were found. Yet the milk of both these cows was infective, as shown by experiment, *i.e.*, they contained tubercle bacilli. In both cases the disease of the udder was not so advanced as in Cows 20, 21, and 25. It is probable that if a larger number of preparations of milk were made, tubercle bacilli would have been found in the milk from Cows 8 and 24; but the chief point to be made prominent is that the discovery of tubercle bacilli in the milk from such cases is by no means an easy task. The labour of thoroughly examining 40 preparations for tubercle bacilli is not light, and the bacilli may, as was seen in Cow No. 24, be absent in this number of preparations, and yet the milk prove infective. It is in the early cases of tuberculosis of the udder in which a diagnosis is most important. It is clear, from the facts stated, that if the diagnosis rest solely on the discovery of tubercle bacilli in a certain number of preparations of the milk, that a great mistake might be made, as cases of disease of the udder might be decided as non-tuberculous when they were not only tuberculous, but the udder was giving infective milk.

In all suspected cases, however, the milk ought to be examined for tubercle bacilli, and especially the milk given by the most affected quarter of the udder, since the finding of tubercle bacilli at once decides the question.

δ. *The results of inoculation of milk into animals.*

164 There is only one means by which the diagnosis of tuberculosis of the udder is made with absolute certainty in the early stage, and this is by injecting the milk into animals, preferably guinea-pigs. If the milk-inoculation produces tuberculosis, the udder is the seat of tuberculosis. In this way it can be with certainty determined whether a tuberculous cow has tuberculosis of the udder or not, and whether any evident disease of the udder is tuberculous or not. The facts proving this point have already been stated, but they may be mentioned again, as they are of such great importance. Thus, in the inoculation experiments made with the milk of the four classes of cows (p. 34), the following results were obtained :—

1. Eight cows the subject of tuberculosis of the internal organs, but without disease of the udder: of 28 animals inoculated with the milk, from 1 cc. to 10 cc. in each, none developed tuberculosis. (Table XXV., p. 36.)
2. Two cows the subject of tuberculosis of the internal organs, and with non-tuberculous disease of the udder: of 14 animals inoculated, each with 1 cc. of milk, not one developed tuberculosis. (Table XXIX., p. 40.)
3. Two cows with non-tuberculous disease of the udder and no signs of tuberculosis of the internal organs: of 14 animals inoculated, each with 1 cc. to 10 cc. of milk, not one developed tuberculosis (*see* p. 40).
4. Five cows the subject of tuberculosis of the internal organs, and of tuberculosis disease of the udder in different stages: of 21 animals inoculated, each with 0·05 to 10 cc. of milk, all developed tuberculosis (Table XXVII., p. 38).

165 These results speak for themselves and hardly any comment is necessary. A few remarks may be made, however, as to the best way of applying this inoculation test of the infectivity of milk. The animals to be used are guinea-pigs, and the amount to be injected is 2 cc. If the milk is freshly drawn (*i.e.*, not more than 24 hours old), the injection may be made into the peritoneal cavity, and the signs of tuberculosis are seen in from 10 to 14 days in the great omentum which teems with tubercle bacilli. The inoculation may, in other cases, be made under the skin of the groin just inside the nipple. A microscopical diagnosis of any lesion produced in 14 to 21 days is readily made by preparing coverglasses smeared with the excised diseased mass. Within the period mentioned the inguinal glands become tuberculous. The most rapid method is, however, the intraperitoneal injection.

The questions just discussed as regards the diagnosis of tuberculosis of the udder may be summarised in the following manner :—

1. The gradual origin and extension of tuberculosis of the udder distinguishes it to some extent from inflammatory disease of the udder; a hard, nodular, and painless enlargement of one or more quarters is in favour of tuberculosis. But no reliance can be placed on these characteristics for the diagnosis of the disease.
2. An examination of the milk shows that—
   - α. In the early stage of tuberculosis of the udder, where the secretory gland tissue is but little affected (Cows 8 and 24), the milk may be natural in appearance; it may be nearly normal on analysis (showing perhaps a slight diminution in the amount of casein and of lactose); and it may show no tubercle bacilli in a moderate number of preparations made; while it is infective, as it invariably produces tuberculosis when injected into animals.
   - β. In the more advanced stages of tuberculosis of the udder, where one or more quarters of the udder show well-marked tuberculosis of the secretory gland tissue, the milk alters in appearance, owing to the casein becoming coagulated; it shows a diminution of lactose; tubercle bacilli are readily found; and the milk is highly infective.

On the Question of the Condemnation of the Milk of Tuberculous Cows as unfit for Human Consumption.

166 This question is answered by the results of the experiments which have been brought forward. The milk of all cows with tuberculosis of the udder is unfit for human consumption; therefore the milk of all such cows must be prevented from being used either as an article of diet or for the manufacture of butter and other milk products. The matter admits of no compromise whatever. The milk under consideration is so virulent an infective agent that the removal of the cows giving it from dairies is absolutely necessary.

The question arises as to in what manner this can be done practically and with certainty.

1. This can be done, in great part, by excluding from use the milk obtained from all cows with disease of the udder, whether tuberculous or not, or to speak more positively—
   - α. the milk from all cows in which one or more quarters of the udder is enlarged or nodular;
   - β. the milk from all cows in which it is evident that the milk from one or more quarters of the udder fails either in quantity or quality.

   The decision on such a question in a particular cow would not require much expert knowledge.

   In this way, the milk from all well-marked cases of tuberculosis of the udder would be excluded from the common stock of milk. An expert diagnosis could, if necessary, be made subsequently to test whether the disease of the udder is tuberculous or not. The exclusion of all milch-cows with disease of the udder would also prevent the consumption of milk containing pus and pus-producing micro-organisms.
2. Although the presence of tuberculosis of the internal organs does not confer infectivity on the milk, yet it must be remembered that tuberculosis may develop in the udder at any stage of the general disease. It is, therefore, evident that every tuberculous cow giving milk must be looked upon with suspicion. A systematic and regular examination ought to be made of the udders of such cows to determine whether there are any signs of disease; and it would be the safest plan to exclude from the dairy all cows with advancing tuberculosis.

PART IV.

REPORT on the RESULTS of the INJECTION of KOCH'S TUBERCULIN in CALVES and COWS.

167 As there were at different times several tuberculous cows under observation, it was thought of importance to test the effect on them of the subcutaneous injection of different doses of tuberculin, with the view of ascertaining whether this liquid, by producing a well-marked rise of temperature, was of service in the diagnosis of tuberculosis in cattle. The experiments were not very numerous, 11 in all; but so far as they go, they are instructive.

Some of the tuberculin was obtained from Professor Brown, some direct from Berlin.

Before the injection the animal's temperature was taken in the rectum frequently; after the injection it was taken every two hours. The average normal rectal temperature of the cow is 101·5° F. (H. M. Singleton).

The experiments performed were as follows, the details being given on page 44 *et seq.* :—

1. Results in two healthy calves:
   - *a.* One calf, seven and a half months old, injected with 0·2 cc. diluted to 2·5 cc., showed a slight rise of temperature. The average temperature for the six days preceding the injection was 102·2° F., for the 12 hours following, 103·3° F. The highest rise above the highest normal was 1·2° F.
   - *b.* The other calf, 13 months old, injected with 1 cc. of tuberculin (a very large dose) showed also a slight rise of temperature. The average temperature for the eight days preceding the injection was 101·5° F. For the 12 hours following, 102·3° F. The highest rise above the highest normal was 1·1° F.

168 This result, in which the highest rise of temperature produced by the injection of tuberculin in two healthy calves was a little over 1° F., may be compared with that obtained from the injection of similar doses in two tuberculous calves of about the same age as the first.

2. Results in two tuberculous calves:
   - *a.* One calf, eight months old, the subject of tuberculosis of the intestines and mesenteric

glands, injected with 0·2 cc. tuberculin diluted to 2·5 cc., showed a well-marked rise of temperature. The average temperature for the six days preceding the injection was 101·2° F.; for the 28 hours following the injection, 104·4° F. The highest rise above the highest normal was 4·4° F. Although the calf before injection showed no fever, this supervened six hours after the injection, and lasted for 22 hours, when the animal was slaughtered.

b. The other calf, 13 months old, the subject of general tuberculosis, injected with 1 cc. of tuberculin, showed a well-marked rise of temperature. The average temperature for the eight days previous to the injection was 101·6° F.; for the 12 hours following the injection, 104° F. The highest rise above the highest normal was 3·7° F. The calf before the injection showed no fever; the rise of temperature came on six hours after the injection and lasted about six hours. At the site of injection a small hard swelling appeared, which developed into an ulcer, healing in 25 days.

169 These four calves which have just been considered were to all appearances quite healthy during life; they were well nourished, and they had no cough, diarrhœa, or fever. It is evident that the two tuberculous calves could have been diagnosed as such by the injection of tuberculin, because this produced a rise of temperature of about 4° F. as compared with the 1° F. rise produced in the healthy animals. It is important to note that in the two tuberculous calves the disease was active and progressing. Both had been fed with tuberculous material, the first being allowed to live 56 days after the feeding, and the second 259 days. It may be that tuberculin produces a definite rise of temperature in tuberculous cows only when the disease is active.

The results obtained in these calves may be compared with those observed in the tuberculous cows purchased by the Commission.

3. Three cows with moderate tuberculosis (Nos. 16, 17, 12) were injected with doses from 0·2 cc. to 0·5 cc. of tuberculin.

a. Cow No. 16, with old and recent tuberculosis of the lungs and old tuberculosis of the lymphatic glands of the thorax and of the intestines was injected with 0·2 cc. tuberculin diluted to 2·5 cc. This produced a definite rise in temperature. The average temperature for 12 hours on the day preceding the injection was 102·1° F., for the 12 hours following the injection 103·3° F.; and the highest rise above the highest temperature before experiment was 2·8° F.

b. Cow No. 17, with calcareo-caseous tubercle of the lungs, lymphatic glands in the thorax, mesenteric glands and intestines, was injected on two occasions with 0·3 cc. of tuberculin diluted to 3 cc. On the first occasion there was no evident rise of temperature. On the second occasion, one month after the first, there was a definite rise of temperature commencing in eight hours and lasting eight hours. The average temperature for 12 hours on the day preceding the injection was 101·5° F.; for the 12 hours following the injection 103·8° F.; and the highest rise above the highest temperature before experiment was 3·4° F.

c. Cow No. 12, with extensive old and recent tuberculosis of the lungs and of the posterior mediastinal glands, was injected with 0·5 cc. tuberculin diluted to 3·5 cc. It showed a slight rise of temperature. The temperature just before the inoculation was 101·2° F., in two hours after the injection it was 103° F., at which point, or slightly above, it remained for four hours, afterwards falling again. No great rise of temperature was therefore produced.

Of these three cows, therefore, the first two cows (Nos. 16, 17), could have been diagnosed as tuberculous from the results of the injection of tuberculin, the temperature rising from 2·8° to 3·4° F. In the third cow, also tuberculous, no certain diagnosis could have been made, since a temperature of 103° F. is not an abnormal one for the cow.

170 4. With smaller doses of tuberculin no particular result was obtained except a fall of temperature. Three cows, two with moderate tuberculosis (Nos. 15 and 11), one with advanced and generalised tuberculosis (No. 22), were injected with doses of tuberculin from 0·03 cc. to 0·1 cc. diluted.

(*a.*) Cow No. 15, moderate tuberculosis, injected with 0·03 cc. showed no rise of temperature, if anything, a slight fall. The cow was not febrile before the injection.

(*b.*) Cow No. 22, advanced and generalised tuberculosis, injected with 0·05 cc., showed a distinct fall of temperature. This cow was febrile before the injection.

(*c.*) Cow No. 11, moderate tuberculosis, injected with 0·1 cc., showed a slight fall of temperature. The cow was febrile before the injection, the average temperature being 103·75° F.; after the injection the average temperature was 101·9° F.

It is possible that in these three cows the dose given was too small to produce the febrile reaction.

171 5. Another experiment was performed in a non-tuberculous, although diseased, cow. This animal (No. 27) was well-nourished, and showed post-mortem interstitial mastitis and a chronic sub-diaphragmatic abscess, a condition of things which may be described as a chronic pyæmia or pus-infection arising from the disease of the udder. The injection of 0·3 cc. of tuberculin in this cow produced a slight rise of temperature 10 hours after the injection, the fever lasting 12 hours. The average temperature during 9 hours, on the day before the injection was 101·8° F. During the 21 hours following the injection, 102·7° F. The highest rise above the highest temperature before the experiment was 2·8° F. At the site of injection behind the left shoulder a large area of œdema developed, which lasted more than seven days, ultimately disappearing entirely.

These experiments are recorded as suggestive of the value of tuberculin in the diagnosis of tuberculosis in cows.

172 Out of five tuberculous calves and cows injected with doses of tuberculin varying from 0·2 cc. to 1 cc., the disease could be diagnosed from the rise of temperature (2·8° F. to 4·4° F.), in four of the animals, in one no diagnosis was possible as no appreciable rise of temperature occurred. In one of these cows it is to be noted that a first injection of 0·3 cc. gave no result, while a second injection of the same dose produced a well-marked reaction. This may prove a serviceable fact to bear in mind.

Out of three cows injected with doses varying from 0·03 cc. to 0·1 cc., none could have been diagnosed with certainty as tuberculous, since there was a fall of temperature and no rise.

With the two healthy calves, neither could have been diagnosed as tuberculous from the slight rise of temperature produced (a little over 1° F.) Tuberculin is, as is well known, of itself a fever-producing agent irrespective of its action in tuberculosis.

The most noteworthy result followed the injection of tuberculin in the last cow considered above. This cow was the subject of chronic pyæmia, and not only did a definite febrile disturbance occur (a rise of 2·8° F.), but there was an extensive local reaction at the site of injection, resulting in the production of œdema. This cow might well have been diagnosed as tuberculous, as indeed was the case, before the post-mortem examination was made.

It appears, from the experiments, fair to conclude that moderate doses of tuberculin (0·2 to 0·3 cc.) subcutaneously injected is of some service in the diagnosis of tuberculosis in cows, especially if the disease is active; errors of omission and commission in diagnosis are however liable to occur.

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173 Details of the Experiments with the Injection of Koch's Tuberculin in Calves and Cows. The temperature was taken in the rectum.

For the complete record of the post-mortem examination of the cows, see Part V., p. 47; of the calves, see Part IX., pp. 101, 102.

Calf.—Healthy.

Fed with phthisical sputum, but found healthy at the post-mortem examination (*see* p. 102, Calf B, Exp. II.)

1892.		F.
April 6	- 8 a.m.	- 103°.
	2 p.m.	- 102·2°.
	6 p.m.	- 102·6°.
April 7	- 8 a.m.	- 101·2°.
	2 p.m.	- 102·8°.
	6 p.m.	- 103°.
April 8	- 8 a.m.	- 102°.
	2 p.m.	- 102·8°.

1892.		F.	
	6 p.m.	103°.	
April 9	8 a.m.	102°.	
	2 p.m.	102·4°.	
April 10	8 a.m.	102°.	
	2 p.m.	101·8°.	
	6 p.m.	102·4°.	
April 11	8 a.m.	102·2°.	
	2 p.m.	103°.	
	6 p.m.	102·4°.	
April 12	10·15 a.m.	102·4°.	
	10 30 a.m.	—	Injection of 0·2 cc. tuberculin diluted to 2·5 cc. subcutaneously.
	12 noon	102°.	
	2 p.m.	102·8°.	
	4 p.m.	102·4°.	
	6 p.m.	104°.	
	8 p.m.	104·2°.	
	10 p.m.	103·6°.	
	12 midnight	104°.	
April 13	4 a.m.	102·2°.	
	6 a.m.	101·2°.	
	8 a.m.	102·4°.	
	10 a.m.	102·6°.	
	12 noon	102·2°.	
	2 p.m.	102·2°.	
	4 p.m.	101·8°.	

Result.—The injection of 0·2 cc. of tuberculin in a healthy calf produced a slight rise of temperature. The average temperature for the six days preceding the injection was about 102·2° F.; for the 12 hours following the injection, 103·3° F.

Calf.—Healthy.

174 Fed with phthisical sputum, but found healthy at the post-mortem examination (*see* p. 102, Calf D, Exp. I.)

1892.		F.	
March 2	9 a.m.	101·5°.	
	1 p.m.	102°.	
	5 p.m.	100°.	
	7 p.m.	101·6°.	
	10 p.m.	101·3°.	
March 3	9 a.m.	101·3°.	
	1 p.m.	101·1°.	
	5 p.m.	102·2°.	
	7 p.m.	102·3°.	
	10 p.m.	101·3°.	
March 4	9 a.m.	102°.	
	1 p.m.	101·1°.	
	5 p.m.	102·3°.	
	7 p.m.	101·3°.	
	10 p.m.	101°.	
March 5	9 a.m.	101·1°.	
	1 p.m.	101·3°.	
	5 p.m.	101·4°.	
	7 p.m.	101·4°.	
	10 p.m.	101·3°	
March 6	9 a.m.	101·4°.	
	1 p.m.	101·2°.	
	5 p.m.	103°.	
	10 p.m.	101·3°.	
March 7	1 p.m.	102°.	
	5 p.m.	102°.	
	7 p.m.	101·3°.	
March 8	9 a.m.	100·3°.	
	1 p.m.	102·1°.	
	5 p.m.	101·3°.	
	7 p.m.	101·2°.	
	10 p.m.	102·2°.	
March 9	9 a.m.	101·1°.	
	1 p.m.	101·3°.	
	5 p.m.	101·4°.	
	7 p.m.	102·2°.	
	10 p.m.	101·2°.	
March 10	9 a.m.	101·2°.	
	10.30 a.m.	—	Injection of 1 cc. tuberculin, undiluted.
	11.30 a.m.	101·3°.	
	12.30 p.m.	101·2°.	
	2.30 p.m.	101·4°.	
	4.30 p.m.	102·3°.	
	6.30 p.m.	103·1°.	
	8.30 p.m.	103·1°.	
	10.30 p.m.	104·1°.	
1892.			
March 11	7 a.m.	101·2°.	
	9 a.m.	101·3°.	
	11 a.m.	101·3°.	
	1 p.m.	101·1°.	
	3 p.m.	101·3°.	
	5 p.m.	102°.	
	7 p.m.	102·1°.	
	9 p.m.	102·1°.	

Result.—The injection of 1 cc. of tuberculin in a healthy calf produced a slight rise of temperature six hours after injection. The average temperature for the eight days preceding the injection was 101·5° F; for the 12 hours following the injection, 102·3° F.

Calf.—Tuberculous.

175 Calf fed with phthisical sputum. Tuberculosis of intestines and mesenteric glands (*see* p. 102, Calf A, Exp. II.).

1892.		F.	
April 6	8 a.m.	101·2°.	
	2 p.m.	100·8°.	
	6 p.m.	101°.	
April 7	8 a.m.	101°.	
	2 p.m.	101°.	
	6 p.m.	101·6°.	
April 8	8 a.m.	101°.	
	2 p.m.	101·4°.	
	6 p.m.	101·8°.	
April 9	8 a.m.	101·2°.	
	2 p.m.	102·2°.	
April 10	8 a.m.	101·4°.	
	2 p.m.	101°.	
	6 p.m.	101·8°.	
April 11	8 a.m.	101·2°.	
	2 p.m.	101·6°.	
	6 p.m.	101·2°.	
April 12	10.15 a.m.	101·2°.	
	10.30 a.m.	—	Injection of 0·2 cc. tuberculin diluted to 2·5 cc., subcutaneously.
	12 noon	101·4°.	
	2 p.m.	100·8°.	
	4 p.m.	102·4°.	
	6 p.m.	103·8°.	
April 12	8 p.m.	103·2°.	
	10 p.m.	106°.	
	12 midnight	105·4°.	
April 13	4 a.m.	104·2°.	
	6 a.m.	106·6°.	
	8 a.m.	105·6°.	
	10 a.m.	106°.	
	12 noon	105·2°.	
	2 p.m.	106°.	
	4 p.m.	104·6°.	

Result.—The injection of 0·2 cc. of tuberculin in a calf with slight, but active, tuberculosis of the intestine and mesenteric glands produced a well-marked rise of temperature about six hours after the injection. The average temperature for the six days preceding the injection was 101·2° F.; for the 28 hours following the injection nearly 104·4° F.

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176 Calf.—Tuberculous.

Calf fed with bovine tuberculous material (*see* p. 101, Calf D). Tuberculosis of intestine, mesenteric, and other abdominal lymph glands, of those in thorax, and of pleura.

1892.		F.
March 2	9 a.m.	102°.
	1 p.m.	102°.
	5 p.m.	100·4°.
	7 p.m.	101·3°.
	10 p.m.	101·4°.
March 3	9 a.m.	101·4°.
	1 p.m.	101·2°.
	5 p.m.	102·3°.
	7 p.m.	102·1°.
	10 p.m.	100·4°.
March 4	9 a.m.	102·1°.
	1 p.m.	101·2°.
	5 p.m.	102·4°.
	7 p.m.	102°.
	10 p.m.	100·4°.
March 5	9 a.m.	102°.
	1 p.m.	102·1°.
	5 p.m.	102·1°.

1893.		F.	
	7 p.m.	102°.	
	10 p.m.	101·4°.	
March 6	9 a.m.	102·1°.	
	1 p.m.	101·3°.	
	5 p.m.	102·4°.	
	10 p.m.	102°.	
March 7	1 p.m.	101·4°.	
	5 p.m.	102·1°.	
	7 p.m.	102·2°.	
March 8	9 a.m.	101·2°.	
	1 p.m.	102·3°.	
	5 p.m.	101·4°.	
	7 p.m.	101·1°.	
	10 p.m.	101·4°.	
March 9	9 a.m.	101·3°.	
	1 p.m.	102·1°.	
	5 p.m.	101·4°.	
	7 p.m.	102°.	
	10 p.m.	101·4°.	
March 10	9 a.m.	102°.	
	10.45 a.m.	—	Injection of 1 cc. tuberculin, undiluted.
	11.30 a.m.	102·3°.	
	12.30 p.m.	102·2°.	
	2.30 p.m.	102·3°.	
	4.30 p.m.	104·2°.	
	6.30 p.m.	106·1°.	
	8.30 p.m.	105·4°.	
	10.30 p.m.	105·1°.	
March 11	7 a.m.	102·1°.	
	9 a.m.	102·1°.	
	11 a.m.	102°.	
	1 p.m.	101°.	
	3 p.m.	101°.	
	5 p.m.	101·4°.	
	7 p.m.	102°.	
	9 p.m.	101·2°.	

Result.—The injection of 1 cc. of tuberculin in a tuberculous calf showed in about six hours a distinct rise of temperature. The average temperature of the calf for the eight days preceding the injection was 101·6° F.; for the 12 hours succeeding the injection was nearly 104° F.

Cow 16.—Moderate Tuberculosis.

177 Tuberculosis of lungs and lymphatic glands in the thorax.

1892.		F.	
June 8	10 a.m.	100·2°.	
	2 p.m.	102°.	
	6 p.m.	103·4°.	
	10 p.m.	102·1°.	
June 9	10 a.m.	101·1°.	
	3 p.m.	103°.	
	6 p.m.	102·4°.	
	10 p.m.	102°.	
June 10	9.30 a.m.	100·4°.	
	10 a.m.	—	Injection of 0·2 cc. tuberculin diluted to 2·5 cc., subcutaneously.
	12 noon	101·4°.	
	2 p.m.	102·4°.	
	4 p.m.	105·2°.	
	6 p.m.	106°.	
	8 p.m.	103·1°.	
	10 p.m.	103°.	
	12 midnight	102·4°.	
June 11	4 a.m.	101·4°.	
	6 a.m.	101·4°.	
	8 a.m.	101·2°.	
	10 a.m.	100·2°.	
	12 noon	99·8°.	
	2 p.m.	100·1°.	
	6 p.m.	102°.	
June 12	5.15 a.m.	100·2°.	
	9 a.m.	100·3°.	
	1 p.m.	100·2°.	
	5 p.m.	100·4°.	
June 13	9 a.m.	100·2°.	

Result.—The injection of 0·2 cc. of tuberculin produced in a cow with moderate tuberculosis a definite rise in temperature six hours after the injection. The average temperature for 12 hours on the day preceding the injection was 102·1° F.; for the 12 hours following the injection, 103·3° F.; the highest rise above the highest before injection being 1·8° F.

Cow 17.—Moderate Tuberculosis.

178 Tuberculosis of the lungs, lymphatic glands in the thorax, intestines, and mesenteric glands.

First Inoculation.

1893.		F.	
Feb. 21	7.30 p.m.	103·6°.	
Feb. 22	8 a.m.	100·8°.	
	11.30 a.m.	—	Injected with 0·3 cc. tuberculin diluted to 3 cc., subcutaneously.
	12 noon	100·6°.	
	2 p.m.	101°.	
	4 p.m.	101·4°.	
	6 p.m.	103°.	
	8 p.m.	103·2°.	
	10 p.m.	102°.	
	12 midnight	103°.	
Feb. 23	6 a.m.	103·8°.	
	9 a.m.	102·6°.	

Result.—The injection of 0·3 cc. of tuberculin produced no great rise of temperature, although the animal in six hours after the injection was slightly febrile for 15 hours.

Second Inoculation.

1893.		F.	
March 19	9 a.m.	101°.	
	2 p.m.	101·6°.	
	6 p.m.	102·2°.	
	10 p.m.	101·2°.	
March 20	9 a.m.	101·8°.	
	2 p.m.	102°.	
	2.5 p.m.	—	Injected with 0·3 cc. tuberculin diluted to 3 cc., subcutaneously.
	4 p.m.	102°.	
	6 p.m.	102·2°.	
	8 p.m.	102·6°.	
	10 p.m.	105°.	
	12 midnight	105·6°.	
March 21	2 a.m.	105·4°.	
	6 a.m.	103·2°.	
	8 a.m.	103·4°.	
	12 noon	102·6°.	
	2 p.m.	102·6°.	
	4 p.m.	102·6°.	
	8 p.m.	101·6°.	
	12 midnight	101·6°.	
	8 a.m.	101°.	

Result.—A second injection of the same dose of tuberculin 27 days after the first, produced a definite rise of temperature in eight hours. The average temperature for 12 hours on the day preceding the injection was 101·5° F., and for the 12 hours following the injection 103·8° F.

COW 12.—Moderate Tuberculosis.

179 Tuberculosis of lungs and posterior mediastinal glands.

1892.		F.	
October 19	10.20 a.m.	101·2°.	
	10.25 a.m.	—	Injection of 0·5 cc. tuberculin diluted to 3·5 cc., subcutaneously.
	12 noon	103°.	
	2 p.m.	103·2°.	
	4 p.m.	103°.	
	6 p.m.	102°.	
	8 p.m.	102°.	
	1 a.m.	100·8°.	
	5 a.m.	101·2°.	
	8 a.m.	100·6°.	
	12 noon	101°.	
	6 p.m.	101·4°.	
	8 p.m.	101°.	

Result.—The injection of 0·5 cc. of tuberculin in a cow with moderate tuberculosis produced a slight rise of temperature within two hours after inoculation.

COW 15.—Moderate Tuberculosis.

180 Well-marked tuberculosis of lungs and of the lymph glands in the thorax, few "grapes" on pleura.

1892.		F.
July 17	8 a.m.	101·2°.
	12 noon	102·3°.
	p.m.	102·3°.

1893.		F.	
	8 p.m.	102·3°.	
July 18	8 a.m.	101·6°.	
	12 noon	102·3°.	
	4 p.m.	102·1°.	
	8 p.m.	102·3°.	
	12 midnight	101·2°.	
July 19	11 a.m.	101·2°.	
	11.5 a.m.	—	Injection of 0·03 cc. tuberculin diluted to 1·5 cc., subcutaneously.
	2 p.m.	102·3°.	
	6 p.m.	101°.	
	8 p.m.	100·2°.	
	10 p.m.	100·2°.	
	2 a.m.	100°.	
	6 a.m.	100·1°.	
	10 a.m.	101·2°.	
	2 p.m.	101·2°.	
	6 p.m.	101°.	
	8 p.m.	101·4°.	
	10 p.m.	101·2°.	

Result.—The injection of 0·03 cc. of tuberculin produced in this case of moderate tuberculosis no rise of temperature; if anything, a slight fall.

COW 22.—Advanced and Generalised Tuberculosis.

181 Tuberculosis of the serous membranes, lungs, lymphatic glands of thorax, kidneys, intestines, and mesenteric glands.

1892.		F.	
July 17	8 a.m.	100°.	
	12 noon	101°.	
	4 p.m.	102·1°.	
	8 p.m.	104°.	
July 18	8 a.m.	99·4°.	
	12 noon	103·4°.	
	4 p.m.	104·1°.	
	8 p.m.	103·2°.	
	12 midnight	102·2°.	
July 19	11 a.m.	102·2°.	
	11·5 a.m.	—	Injection of 0·05 cc. tuberculin diluted to 2·5 cc., subcutaneously.
	2 p.m.	102·2°.	
	6 p.m.	100·4°.	
	8 p.m.	102·3°.	
	10 p.m.	103·1°.	
July 20	2 a.m.	103·4°.	
	6 a.m.	101·2°.	
	10 a.m.	103°.	
	2 p.m.	101·3°.	
	6 p.m.	101°.	
	8 p.m.	100·2°.	
	10 p.m.	100·4°.	

Result.—The injection of 0·05 cc. of tuberculin in a cow with advanced and generalised tuberculosis produced no rise of temperature, which was higher before the injection than after it.

COW 11.—Moderate Tuberculosis.

182 Tuberculosis of the lungs and bronchial glands; to a slight extent of liver.

1892.		F.	
September 6	12 noon	103·2°.	
	4 p.m.	104·4°.	
	8 p.m.	104°.	
	12 midnight	103·4°.	
September 7	8 a.m.	101·4°.	
	10.20 a.m.	—	Injection of 0·1 cc. tuberculin diluted to 5 cc., subcutaneously.
	12 noon	102·2°.	
	2 p.m.	102·4°.	
	4 p.m.	102·4°.	
	8 p.m.	101·4°.	
	12 midnight	101·2°.	
September 8	4 a.m.	100·2°.	
	8 a.m.	100·4°.	
	12 noon	102°.	

Result.—The injection of 0·1 cc. of tuberculin in a cow with moderate tuberculosis produced a slight fall of temperature, and not a rise. The average proportion of a period of 12 hours preceding the injection was 103·75° F., of a similar period following 101·9° F.

COW 27.—Non-Tuberculous.

183 A sub-diaphragmatic non-tuberculous abscess; interstitial mastitis.

1893.		F.	
February 16	1 p.m.	102°.	
	5 p.m.	101·6°.	
	9 p.m.	101·8°.	
February 17	9 a.m.	101·2°.	
	11.45 a.m.	—	Injection of 0·3 cc. tuberculin diluted to 3 cc., subcutaneously.
	2 p.m.	101·4°.	
	4 p.m.	102°.	
	6 p.m.	102·2°.	
	8 p.m.	102°.	
	10 p.m.	102·6°.	
	12 midnight	103°.	
February 18	6 a.m.	104·8°.	Œdema at site of injection, over an area 8 inches in diameter on February 19th; persisted till after February 24th, and gradually disappeared.
	9 a.m.	104°.	
	12 noon	101·2°.	
	6 p.m.	101°.	
February 19	9 a.m.	100·4°.	

184 *Result.*—The injection of 0·3 cc. of tuberculin in a non-tuberculous cow suffering from a chronic internal abscess produced a slight rise of temperature over 12 hours following the injection. The average temperature for nine hours on the day preceding the injection was 101·8° F.; for the 19 hours following the injection, 102·7° F.

INQUIRY II.

185 Part V.

Details of the Post-mortem Examinations of the Cows the meat or milk of which was used for experiment.

Total number of cows, 27 :—

Cows with mild tuberculosis	8
Cows with moderate tuberculosis	10
Cows with advanced and generalized tuberculosis	7
Cows with disease of the udder (non-tubercular) and no tuberculosis in body	2

In the records not only the naked-eye appearances of the organs are given, but the microscopical examination of the meat and of the tuberculous organs.

Abbreviations used :—

T.B. = tubercle bacilli.
T.B. x. = small number of tubercle bacilli.
T.B. xx. = large number of tubercle bacilli.
T.B. xxx. = very large number of tubercle bacilli.

Cows with Mild Tuberculosis, 8.

The meat from each of these was used for experiment, and the milk from two (7, 8).

COW 1.

Post-mortem aminati

Killed and examined at Cattle Market, September 8th, 1892. Moderately well nourished.

Serous membranes:

(i.) *Pleuræ.*—The left pleura showed at its lower third on both the parietal and visceral surfaces some thick masses of "grapes."
(ii.) *Pericardium.* } Quite normal.
(iii.) *Peritoneum.* }

Organs:

(i.) *Lungs.* — Left showed a caseating nodule ($2\frac{1}{2} \times 1\frac{1}{2}$ inches) in the lower lobe beneath the surface. The right lung was normal.
(ii.) *Kidneys.* } Quite normal.
(iii.) *Suprarenals.* }
(The other organs had not been preserved.)

Lymph glands:

Bronchial. } Normal.
Lumbar. }
Popliteal.—Showed one or two doubtful nodules.

Microscopical diagnosis of Tubercle:
"*Grapes.*"—Ten sections; caseous tubercle; T.B. x.
Popliteal gland.—Normal, except one small area where bacteria and an early cell-necrosis were seen; no tubercle bacilli; not tubercular.

Meat was of moderately good colour; no tubercle visible to naked eye.

Microscopical examination.—*Rump*, eight sections; normal.

COW 2.

Killed and examined at Cattle Market, August 12, 1892. The animal was very well nourished.

ost-ortem examination.

Serous membranes:
(i.) *Pleuræ.*—Attached to the pleural surface of the diaphragm were numerous "grapes." Some few were also met with attached to the visceral pleura at the apices of the lungs.
(ii.) *Peritoneum.*—On the peritoneal surface of the diaphragm were numerous "grapes," of sizes varying from a pea to a walnut, some few of which were caseating.

Organs
Lungs were quite normal on section.
Kidneys.—Normal.
(The other organs had not been preserved.)

Lymph glands:
Bronchial, *Mediastinal*, *Popliteal*, were quite normal.
The lumbar and cœliac glands had been removed.

Meat.—The meat was of very good colour; no visible tubercle.

Microscopical examination.—*Rump*; six sections; a round-celled infiltration at one spot; no caseation; no tubercle bacilli; not tubercular.

COW 3.

Killed at Cattle Market, November 17th, 1891. The carcase was dressed when examined, and would have passed inspection. The animal was moderately well nourished.

ost-ortem examination.

Serous membranes:
(i.) *Pleuræ*, (ii.) *Peritoneum*, (iii.) *Pericardium*, were normal.

Organs:
Lungs showed no tubercle.
Kidneys.—Normal.
(Other organs had not been preserved.)

Lymph glands:
Bronchial, and *posterior mediastinal.*—Enlarged; well-marked caseous and calcareous tubercle.
Lumbar.—Enlarged; no tubercle to naked eye.
Popliteal.—Not enlarged; no naked-eye tubercle.

Microscopical diagnosis of Tubercle:
Bronchial gland.—Six sections; showed caseous tubercle, with numerous giant cells; no tubercle bacilli; normal gland tissue in parts.
Popliteal gland.—Six sections; normal.
Lumbar gland.—Fifteen sections: nine sections showed normal glandular structure; three showed one focus of early cell-necrosis, and three others two foci in each section. No tubercle bacilli.

Meat.—Normal in appearance; no naked-eye tubercle.

Microscopical examination.—*Rump*; six sections; normal; cocci at edge of sections.

COW 4.

Milch cow, slaughtered as a "contact" animal at Cattle Market, June 2nd, 1891.

st-ortem examination.

1. *Serous membranes.*—*Pleuræ* adherent and covered everywhere with yellowish brown "grapes." *Peritoneum* and *pericardium*, normal.
2. *Lungs.*—Normal, except for a hydatid cyst, size of a chestnut, in left lung.
3. *Kidneys.*—Normal.
4. *Lymphatic glands.*—Caseous tubercle in some of the *bronchial* glands, in the *posterior mediastinal*, and in the *lumbar* glands, two of which on section show several recent tubercles in the cortex of the gland.

All other organs had been removed before examination.

Microscopical diagnosis of Tubercle.—*Pleura.*—The "grapes" on section show round cells, large and small, with giant-cells; no caseation; no tubercle bacilli found in 16 sections.

Meat.—Normal in appearance; firm:
Rump.—Ten cover-glass preparations of the squeezed juice show no tubercle bacilli. Seven sections show normal muscle structure; no tubercle bacilli.
Loin.—Ten cover-glass preparations of squeezed juice; no tubercle bacilli. Six sections show normal muscle structure; no tubercle bacilli.
Breast.—Ten cover-glass preparations of squeezed juice; no tubercle bacilli. Eleven sections: 10 are normal; one shows a small collection of round cells; no tubercle bacilli.

Therefore in 30 preparations of the muscle juice no tubercle bacilli was present. In 24 sections of the muscle no tubercle was present.

COW 5.

Killed at Cattle Market, November 17th, 1891. The carcase was well nourished and moderately fat; would have passed inspection.

Post-mortem examination.

Serous membranes:
(i.) *Pleuræ* thickly covered with "grapes"; not caseating.
(ii.) *Peritoneum.*—Normal.

Organs:
Lungs showed a few scattered miliary granulations. There was no caseous tubercle.
Kidneys.—Normal.
(The other organs had not been preserved.)

Lymph glands:
Bronchial and *posterior mediastinal* showed caseous tubercle.
Lumbar.—Normal.
Popliteal.—Not enlarged; no naked-eye tubercle.

Microscopical diagnosis of tubercle:
Pleura.—Thirteen sections; caseous tubercle; no tubercle bacilli found.
Lungs.—Eleven sections; "grapes" attached showed numerous giant-cells; T.B. x; lung tissue normal.
Popliteal gland.—Fifteen sections; normal.

Meat.—No tubercle visible to naked eye.

Microscopical examination.—*Rump*, eight sections; normal; a few groups of cocci between the muscular fibres.

COW 6.

Killed and examined at Cattle Market, March 25th, 1892. The animal was well nourished.

Post-mortem examination.

Serous membranes:—
(i.) *Pleuræ.*—Both the visceral and parietal layers of the pleura were covered with "grapes."
(ii.) *Pericardium.*—Normal.

Organs:
Lungs were slightly affected with tubercle.
Kidneys.—Normal.
(The other organs had not been preserved.)

Lymph glands:
Mediastinal.—Some were slightly enlarged and showed tubercle just commencing.
Pelvic.—Showed very early tubercle; only one or two were affected.
Popliteal.—Normal.

Microscopical diagnosis of Tubercle.—Grapes; 10 sections; showed fibroid tubercle; no caseation; T.B. x.

Meat.—The muscles were darker than natural: four cover-slip preparations were made of the expressed meat-juice; no tubercle bacilli.

Microscopical examination.—*Rump*, nine sections; normal.

COW 7.

Killed and examined at Harrow, November 22nd, 1893. Cow was very much emaciated.

m ex- tion.

Serous membranes:
(i.) *Pleuræ*,
(ii.) *Pericardium*, were all quite normal.
(iii.) *Peritoneum*,

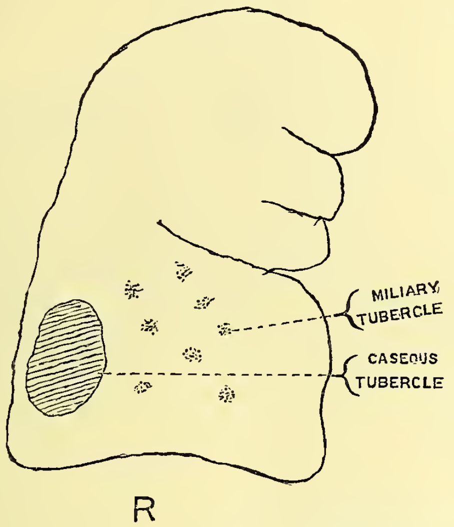

Fig. 1. Diagram of lungs of Cow 7.

Organs:
(i.) *Lungs.*—There was a caseous nodule at each base and a few miliary tubercles scattered about in the substance of the lung-tissue.
(ii.) *Liver* showed several areas of caseating tubercle.
(iii.) *Spleen.*—There was a nodule of tubercle on its inner surface.

All other organs were quite normal.

Lymph glands:
Bronchial slightly tubercular.
Post mediastinal.—Calcareo-caseous tubercle.
Glands in lesser omentum.—Caseous tubercle.

The mesenteric, lumbar, pelvic, and popliteal glands and the supra-mammary glands were quite normal.

The *intestines* were normal.

Microscopical diagnosis of Tubercle.—Liver.—Fifteen sections; caseous tubercle; T.B. x.

Meat was of good colour; no visible tubercle.

COW 8.

Killed and examined at Harrow, November 23rd, 1892. The animal was well nourished.

m ex- tion.

Serous membranes:
(i.) *Pleuræ*,
(ii.) *Pericardium*, were all quite normal.
(iii.) *Peritoneum*,

Organs:
(i.) *Lungs.*
(ii.) *Liver.*
(iii.) *Spleen.*
(iv.) *Heart.*
(v.) *Uterus and vagina.*
(vi.) *Kidneys and adrenals.*
None of these organs were affected with tubercle.

Lymph glands:
Mesenteric.—Several showed tubercle, some caseous but mostly calcareous.
Supra-mammary.—Were enlarged, matted together, and showed caseo-calcareous turbercle.
In lesser omentum.—One gland showed caseous turbercle.

The bronchial, mediastinal, cœliac, lumbar, pelvic, and popliteal glands were quite normal.

Intestines.—Small intestines showed numerous small calcifying nodules in the mucous membrane between the Peyer's patches. The large gut was quite normal.

Udder.—The left posterior teat had been amputated. Both left quarters were fused together and solid, showing on sections numerous sinuous cavities (ducts) full of caseous material. The right quarters were normal to the naked eye.

Microscopical examination of udder:

Mammary duct.—Nine sections. Contents of duct; caseous matter, cells, T.B. xx. The duct wall showed a small round cell infiltration; no tubercle bacilli.

Udder, left anterior quarter.—Sparsely scattered miliary tubercle; no caseation; no tubercle bacilli.

Udder, right anterior quarter.—Eleven sections; at one point a collection of small rounds cells; no caseation; no tubercle bacilli.

Udder, right posterior quarter.—Eleven sections; normal.

Meat firm and of good colour; no visible tubercle.

Microscopical examination.—Rump, twelve sections; normal.

COWS WITH MODERATE TUBERCULOSIS, 10.

The meat of eight (9–16) used for experiment; the milk of seven (Nos. 11, 12, 13, 15, 16, 17, 18).

COW 9.

Cow from Veterinary College, killed June 22nd, 1891.

Post-mortem examination.

1. *Serous membranes.—Pleuræ.*—Adhesions. *Peritoneum and pericardium.*—Normal.

2. *Lungs.*—Extensively tuberculous, with old and recent lesions.

3. *Kidneys.*—Normal.

4. *Lympathic glands.—Bronchial* glands showed calcareo-caseous tubercle. A gland below diaphragm was enlarged and caseous. *Lumbar* glands showed tubercle. *Mesenteric* glands normal.

5. *Udder.*—Small, but normal. Supra-mammary glands enlarged, but equal in size. Normal on section.

Meat.—The muscles of the *diaphragm* and *intercostals* were normal in appearance.

Rump.—Part of the muscular tissue was pale, and showed numerous whitish-yellow nodules, the size of a split pea, over an area of 2½ inches in diameter. Some of the nodules were caseating, and were surrounded with a very hard connective tissue. No tubercle bacilli were found in cover-glass preparations made of the expressed muscle-juice.

Microscopical examination.—Rump, thirteen sections. Seven sections showed two areas of caseous tubercle, very fibroid; no tubercle bacilli. Six sections showed one caseous area; no tubercle bacilli. Extensive fibrosis extending between the muscle fibres.

COW 10.

Killed and examined at the Cattle Market, April 5th, 1892. The animal was well nourished.

Post-mortem examination.

Serous membranes:
(i.) *Pleuræ.*—Normal.
(ii.) *Peritoneum.*—Normal.

Organs:
Lungs.—Both lungs were studded with tubercle, showing caseous patches the size of a bean surrounded with miliary granulations.
Kidneys.—Normal.
(The other organs had not been preserved.)

Lymph glands:
Bronchial,
Posterior mediastinal, } were enlarged and caseous throughout.
Pelvic,
Popliteal.—Enlarged, and showed one or two small nodules the size of a pea.

Microscopical diagnosis of tubercle.—Popliteal gland.—11 sections; caseous tubercle; T.B. x.

Meat.—Was in first-class condition, and of good colour, and showed no visible tubercle; nine cover-slip preparations were made of the expressed meat-juice; no tubercle bacilli.

Microscopical examination.—Rump, nine sections; normal.

COW 11.

Killed and examined at Harrow, September 9th, 1892.

Post-mortem examination.

Serous membranes:
(i.) *Pleuræ,*
(ii.) *Pericardium,* } all quite normal.
(iii.) *Peritoneum,*

Organs:
(i.) *Lungs.*—Both lower lobes were affected throughout with miliary tubercle. There were some few points of caseation. There was a calcified mass the size of a filbert in the upper part of the lower lobe of the right lung. The upper lobes were quite healthy.
(ii.) *Liver.*—There was a small tubercular nodule on the upper surface of the right lobe.
(iii.) *Spleen,*
(iv.) *Heart,*
(v.) *Kidneys,*
(vi.) *Suprarenals,*
(vii.) *Pancreas,* } were all quite normal.
(viii.) *Uterus and vagina,*
(ix.) *Ovaries,*
(x.) *Udder,*

Lymph glands.—All the lymph glands were somewhat softened, but otherwise quite normal, except one of the *bronchial* glands, which showed a small deposit of tubercle.

Intestines.—Normal.

Microscopical diagnosis of tubercle—Lungs, nine sections; caseous tubercle; no normal lung tissue; T.B. xxx.

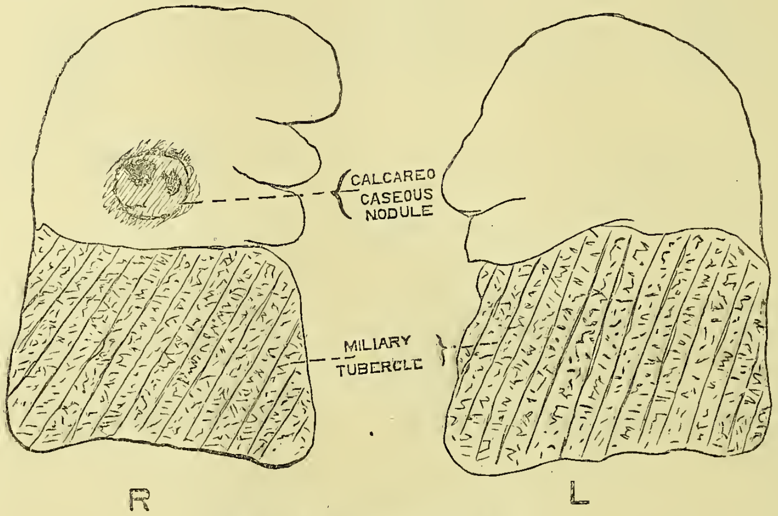

Fig. 2. Diagram of Lungs of Cow 11.

Meat was of good colour, but somewhat boggy, and showed no visible tubercle.

Microscopic examination.—Rump, seven sections; normal.

COW 12.

Killed and examined at Harrow, October 21st, 1892.

Post-mortem examination.

Serous membranes:
(i.) *Pleuræ.*—Adhesions at both bases. No "grapes."
(ii.) *Pericardium,* } were quite normal.
(iii.) *Peritoneum,*

Organs:
(i.) *Lungs.*—Extensively tubercular.

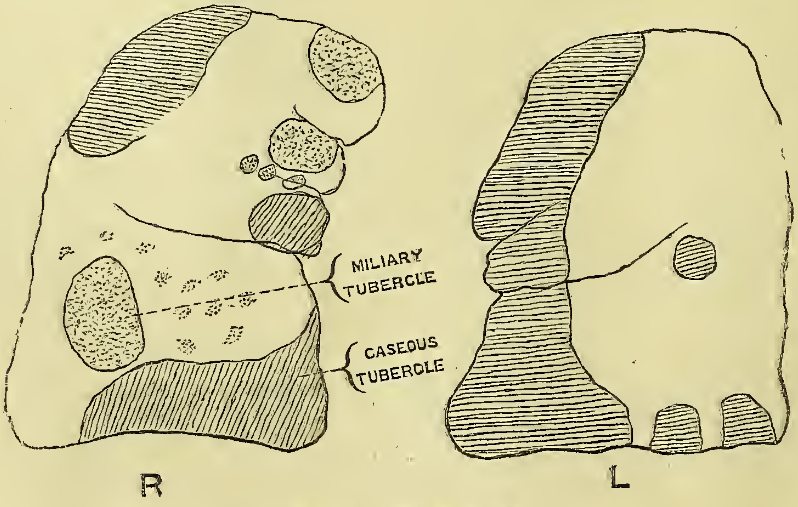

Fig. 3. Diagrams of Lungs of Cow 12.

(ii.) *Liver.*—Showed three hydatid cysts on upper surface; no tubercle.

(iii.) *Spleen,*
(iv.) *Kidneys,*
(v.) *Suprarenals,*
(vi.) *Pancreas,*
(vii.) *Uterus,*
(viii.) *Ovaries,*
(ix.) *Udder,*
were all quite normal.

Lymph glands.—*Posterior mediastinal.*—Four out of eight tubercular; the others were enlarged and fibroid. The bronchial, cœliac, lumbar, popliteal, and mesenteric glands and the glands round the stomach and in the lesser omentum were quite normal.

Intestines.—Showed no ulceration or tubercular deposit.

Microscopical examination:

Lung.—47 sections; caseous areas; surrounded by round cells; innumerable cocci in caseous matter; no tubercle bacilli; fibrous.

Udder.—13 sections; normal.

Meat.—Showed no visible tubercle. Of good colour.

Microscopical examination.—*Rump*, nine sections. In one part there was a collection of round cells around two vessels; no caseation; one tubercle bacillus found. *See* Plate I.

COW 13.

Killed and examined at Harrow, November 11th, 1892. The animal was very thin, the small amount of fat present was of an orange-yellow colour.

a ex-
ion.

Serous membranes:

(i.) *Pleuræ,*
(ii.) *Pericardium,*
(iii.) *Peritoneum,*
all quite normal.

Organs:

(i.) *Lungs* were affected with tubercle, miliary and caseous. The posterior surface of the lower lobes were most affected, and section of the nodules showed caseation in the larger ones, and commencing caseation in the smaller ones.

The *liver, spleen, heart, kidneys, suprarenals, uterus, ovaries*, and *udder* were all normal.

Lymph glands:

Bronchial.—Were matted together, and showed miliary and caseous tubercle.

Posterior mediastinal.—Enlarged and caseous.

Mesenteric.—One only showed a spot of doubtful tubercle.

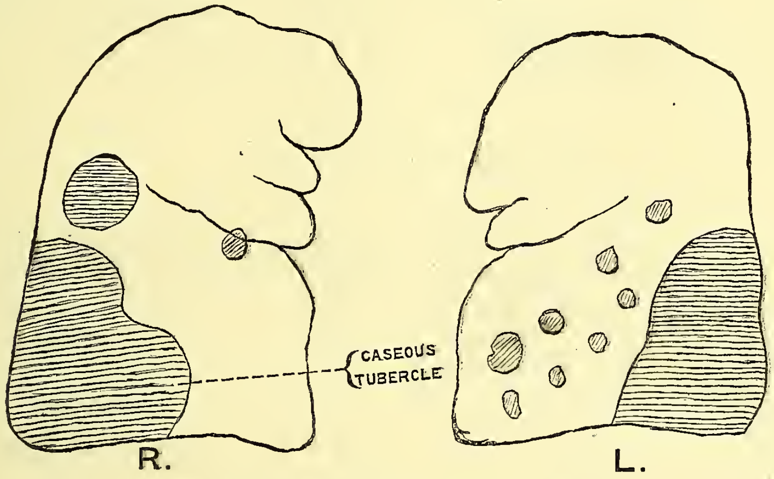

Fig. 4. Diagram of Lungs of Cow 13.

The anterior mediastinal, the iliac, lumbar, cœliac, supra-mammary, and popliteal glands, and the glands in the lesser omentum were normal.

Intestines:

Small gut.—Normal.

Large gut.—Was thinner than normal at its lower part, and there was a good deal of pigmentation. There was no ulceration.

Microscopical examination:

Lung.—Nine sections; caseous tubercle; T.B.

Udder.—Eleven sections; normal.

Meat firm and of good colour; no visible tubercle.

Microscopical examination.—Rump, nine sections normal.

COW 14.

Killed and examined at Cattle Market, November 17th, 1891. The carcase was moderately well nourished and fairly fat. It would have passed inspection.

Post-mortem examination.

Serous membranes:

(i.) *Pleuræ.*—At the lower part were thick bunches of "grapes," some of which were caseating.

(ii.) *Peritoneum.*—Normal.

Organs:

Lungs showed a few large patches of caseous tubercle, and some areas of racemose miliary granulations.

Kidneys.—Normal.

(The other organs had not been preserved.)

Lymph glands:

Bronchial.—Showed advanced yellow caseous tubercle.

Lumbar.—One or two areas of doubtful tubercle.

Popliteal.—Normal to the naked eye.

Mesenteric.—Normal; not enlarged.

Microscopical examination:

Pleuræ.—Six sections; caseous tubercle, with connective tissue around; numerous giant cells; T.B. x.

Lumbar gland.—Eight sections; no caseation; no tubercle bacilli; not tubercular.

Popliteal gland.—Nine sections; normal.

Meat.—Normal in appearance; no visible tubercle.

Microscopical examination.—*Rump*, six sections; normal.

COW 15.

Killed and examined at Harrow, July 21st, 1892.

st- ortem ex- iination.

Serous membranes:

(i.) *Pleuræ.*—Showed a few grapy vegetations along the lines of the ribs, chiefly in the middle of the thorax.

(ii.) *Pericardium.* } Quite normal.
(iii.) *Peritoneum.* }

Intestines:

The *cæcum* and the *small* and *large gut* were quite normal.

Microscopical examination:

Posterior mediastinal gland. — Ten sections; caseous tubercle; T.B.

Udder.—Nine sections; normal.

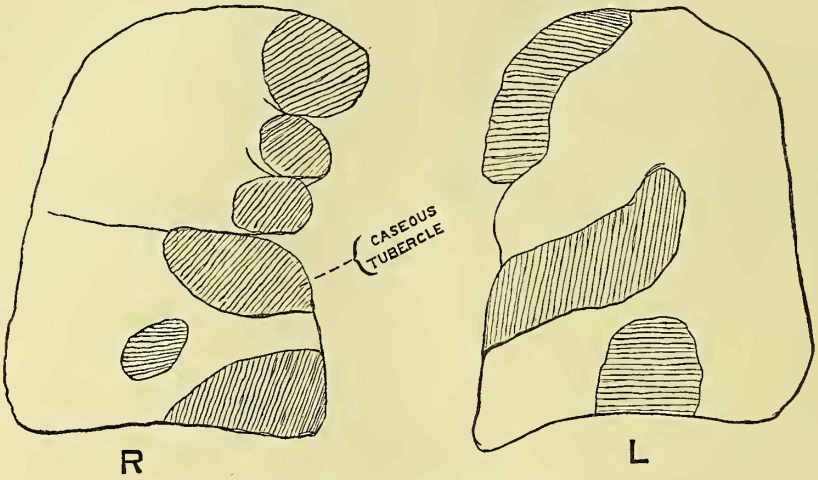

Fig. 5. Diagram of Lungs of Cow 15.

Organs:

(i.) *Lungs.*—Along the anterior borders of both lungs were masses of tubercle, for the most part of superficial extent. The patches were formed by an aggregation of miliary tubercles, which here and there were becoming yellow and caseous.

(ii.) *Liver,*
(iii.) *Spleen,*
(iv.) *Kidneys,*
(v.) *Suprarenals,*
(vi.) *Heart,*
(vii.) *Uterus,*
(viii.) *Ovaries,*
(ix.) *Udder,*
(x.) *Thyroid,*
} were all perfectly normal to the naked eye.

Lymph glands:

Bronchial.—One showed a few miliary tubercles.

Anterior mediastinal.—One showed a few miliary tubercles.

Posterior mediastinal.—Soft and caseating.

Mesenteric.—A few were soft, and showed some minute hæmorrhages into their substance.

The cervical, cœliac, tracheal, lumbar, pelvic, and popliteal glands were all quite normal.

Meat was of a fairly good colour; no visible tubercle.

Microscopical examination.—*Rump,* nine sections; normal.

COW 16.

Killed and examined at Harrow, June 13th, 1892. The animal was very much emaciated.

Post-mortem examination.

Serous membranes:

(i.) *Pleuræ.*—Normal.
(ii.) *Pericardium.*—Normal.
(iii.) *Peritoneum.*—Normal.

Organs:

(i.) *Lungs.*—In the lower half of the left lower lobe were masses of tubercle, which were firm at the edges and breaking down in the centre. There were several other masses about the size of a fist in the lungs, notably one larger than the others in the right lower lobe at its apex, and another at the base.

The right lung contained two parasitic cysts.

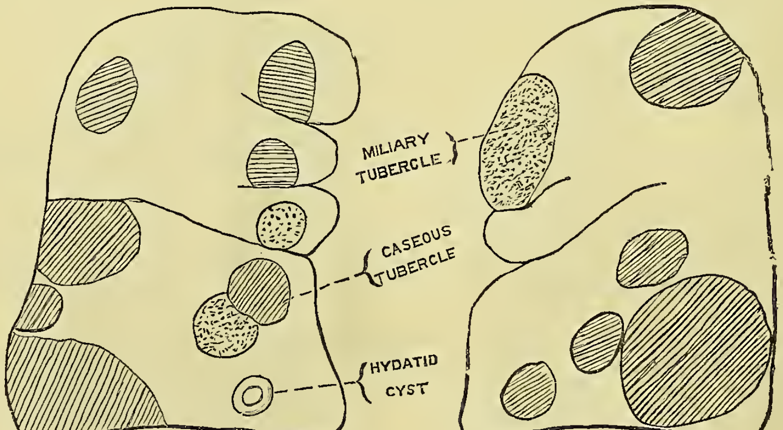

Fig. 6. Diagram of lungs of Cow 16.

The *larynx* and *trachea* were normal.

(ii.) *Liver* contained a small parasitic cyst, and there was a small white spot on its upper surface.

(iii.) *Spleen,*
(iv.) *Kidneys,*
(v.) *Suprarenals,*
(vi.) *Heart,*
(vii.) *Uterus,*
(viii.) *Ovaries,*
(ix.) *Udder,*
} were all quite normal.

Lymph glands:
Bronchial.
Anterior mediastinal.
Posterior mediastinal.
} Enlarged and caseating.

The cervical, cœliac, lumbar, supra-mammary, and popliteal glands, and the glands in the lesser omentum, at the angles of the jaw and behind the stomach, were all normal.

Intestines.—There were several small tubercles scattered throughout the intestines, for the most part in the ileum. The larger nodules, some nearly as large as a small pea, were all cretaceous. A tape worm was found in the intestines.

Microscopical examination:

Lung. — Nine sections; caseous tubercle; no tubercle bacilli.

Liver.—Fourteen sections; normal; no tubercle.

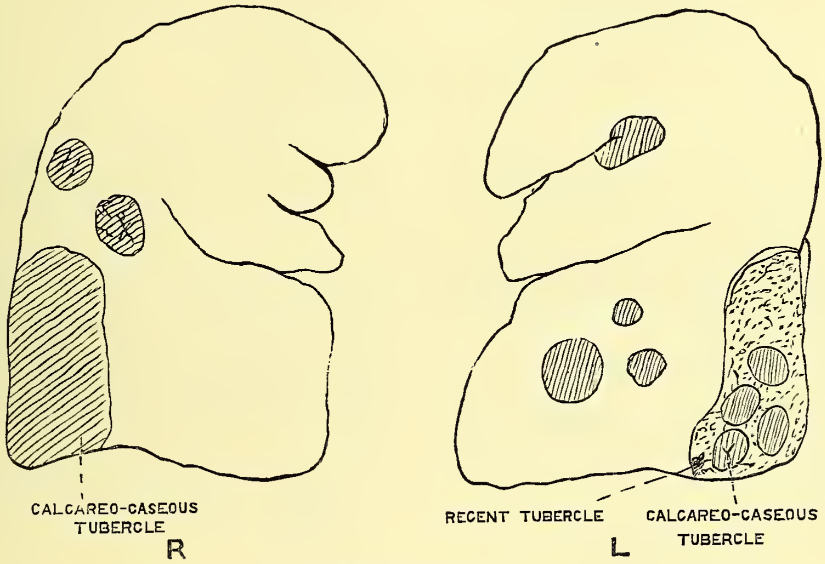

Fig. 7. Diagram of lungs of Cow 17.

Posterior mediastinal gland. — Nine sections; caseous tubercle; giant cells and T.B.

Udder.—Sixteen sections; normal.

Supra-mammary gland.—Thirteen sections; normal.

Intestines. — Eighteen sections; nodules of a tubercular structure in the submucous coat; no tubercle bacilli.

Meat.—Apparently quite normal, but the minced meat was soft and boggy. The meat was of good colour, and showed no visible tubercle.

Microscopical examination. — *Rump,* 10 sections; normal.

COW 17.

Killed and examined at Harrow, March 22nd, 1893. Rather poorly nourished; not much fat. Meat of good colour. The carcase was somewhat moist.

Serous membranes:

(i.) *Pleuræ.*—Both pleuræ showed a few scattered patches of "grapes."

(ii.) *Pericardium.*
(iii.) *Peritoneum.*
} Normal.

Organs:

(i.) *Lungs.*—Both lower lobes of the lungs were affected with caseo-calcareous tubercle.

(ii.) *Liver.*—There was a small parasitic cyst on the under-surface; no tubercle.

(iii.) *Spleen,*
(iv.) *Kidneys,*
(v.) *Suprarenals,*
(vi.) *Uterus,*
(vii.) *Ovaries,*
} were all quite normal.

Lymphatic glands:

Mediastinal.
Bronchial.
} All enlarged; showed large masses of caseo-calcareous tubercle.

Mesenteric.—Two were affected with caseo-calcareous tubercle.

Supra-mammary glands.—Those on the left side were enlarged and hardened; on the right hardened only; no tubercle.

The *lumbar, popliteal,* and *cœliac* glands and *the glands in the lesser omentum* were quite normal.

Intestines.—In the *small gut* were two nodules, and there was an ulcer ¼ inch in diameter in the ileum. *Cæcum* and *large gut* normal.

Udder.—All teats and ducts were normal.

Left posterior quarter.—Normal in appearance; ducts contained coagulated milk; the hard mass felt during life consisted of dense fibrous tissue; no tubercle.

Left anterior quarter.—Normal; milk in ducts not coagulated.

Right posterior quarter.—Normal; milk in ducts not coagulated.

Right anterior quarter. — Harder than normal; no tubercle.

Microscopical examination:

"*Grapes.*"—Four cover-class preparations showed some necrosing cells; no tubercle bacilli.

Bronchial gland. — Two cover-class preparations showed T.B. x.

Lung.—Eleven sections; caseous miliary tubercle; T.B.

Udder.—

Right posterior quarter. — Seventeen sections; normal.

Right anterior quarter.—Twelve sections; in a few parts round-celled infiltration; epithelium of acini normal; no caseation; no tubercle bacilli.

Left anterior quarter.—Seventeen sections; round-celled interstitial infiltration; slight prolification of epithelium of acini; no caseation: no tubercle bacilli.

Left posterior quarter. — Seventeen sections; advanced round-celled and fibroid interstitial infiltration; proliferation of epithelium of acini; destruction of acini; no caseation; no tubercle bacilli.

No other bacteria in any of the sections of the udder.

Meat was of good colour, and showed no visible tubercle.

Microscopical examination:

Rump, nine sections; normal.

Intercostals (beneath "grapes"), ten sections; normal.

COW 18.

Killed and examined at Harrow, February 22nd, 1893. There was very little fat on the body, and what was present was very yellow, almost orange colour. The connective tissues were "soapy" to the touch. The muscles were of dark colour, not bruised, and no nodules of tubercle were apparent to the naked eye.

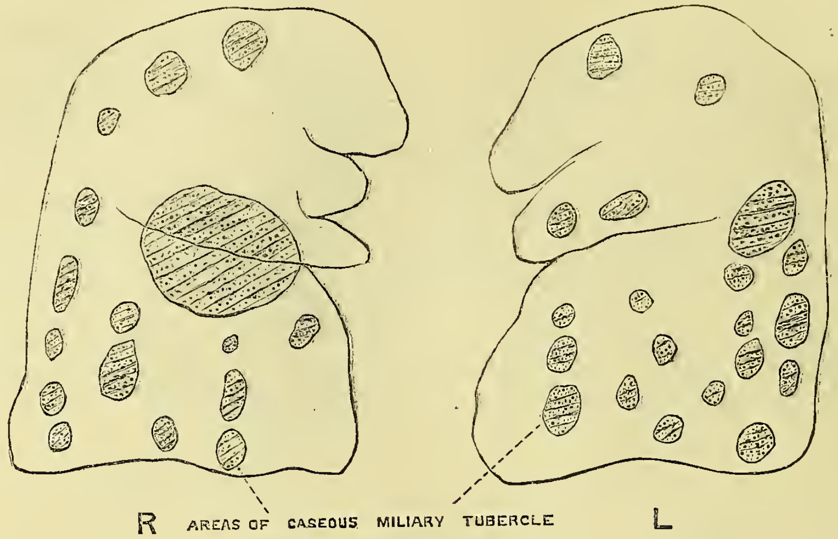

Fig. 8. Diagram of lungs of Cow 18.

Serous membranes:
(i.) *Pleuræ,*
(ii.) *Pericardium,* } were all quite normal.
(iii.) *Peritoneum,*

Organs:
(i.) *Lungs* showed caseating miliary tubercle, especially in the posterior part of the two lower lobes. The right lung was somewhat more affected than the left
(ii.) *Liver* contained two calcified parasitic cysts; no tubercle.
(iii.) *Kidneys.*—Left kidney was normal. There was a doubtful tubercular nobule in the cortical substance, just beneath the capsule of the right kidney.
(iv.) *Suprarenals,*
(v.) *Spleen,*
(vi.) *Heart,* } were all quite normal.
(vii.) *Uterus,*
(viii.) *Ovaries,*

Lymphatic glands:
Post mediastinal,
Bronchial, } were all enlarged, and showed caseo-calcareous tubercle.
Mesenteric,

The *anterior mediastinal, lumbar, cœliac, supra-mammary,* and *popliteal* glands and the *glands in the lesser omentum,* at the *angles of the jaws,* were all quite normal.

Intestines.—*Small gut* showed 27 nodules of tubercle, for the most part calcified.

Cæcum.—Showed five nodules, three of which were calcified.

Rectum and *colon.*—Normal.

Udder.—The left posterior quarter was much harder than the other quarters, and was very nearly dry on section, whereas the other quarters contained milk. This hardness was most marked near the teat. Some nodules of a doubtful nature were found, two white and one yellow. The other quarters were soft and normal. There was no definite caseation, and no evident tuberculosis in any part of the udder.

Microscopical examination.—Four cover-glass preparations were made of the caseous material from a *mesenteric gland;* showed T.B. x x.

Udder:

Right anterior quarter.—Twenty-one sections. Moderate degree of interstitial fibro-cellular infiltration; epithelium of acini normal; no caseation; no tubercle bacilli.

Right posterior quarter.—Twenty sections. Interstitial fibro-cellular infiltration; proliferation of epithelium of acini, and obliteration of some acini; no caseation; no tubercle bacilli.

Left anterior quarter.—Seventeen sections. In exactly same condition as right posterior quarter.

Left posterior quarter.—Twenty-one sections. In the same condition as right posterior and left anterior quarters.

Cows with Advanced and Generalized Tuberculosis, 7.

The meat of five (19–23) used for experiment, and the milk of six (20–25).

COW 19.

From the Veterinary College. Killed June 22nd, 1891. (Post-mortem notes supplied by Dr. Woodhead.)

Post-mortem amination.

Serous membranes.—The *pleuræ, pericardium,* and *peritoneum* were one mass of grapes. The under surface of the diaphragm was especially affected. A large number of tubercle bacilli were found in cover-glass preparations of the juice of the grapes.

Organs:

Lungs.—The upper lobe of the left lung was one mass of tubercle, and there were also other masses in both lungs of caseous and recent tubercle.

Liver,
Kidneys, } were quite normal.
Suprarenals,
Heart,

Udder.—Throughout the whole of the udder were scattered numerous small yellow caseous patches. The posterior quarters were more affected than the anterior.

Lymph glands.—The glands at the root of the lung and the supra-mammary glands were tubercular.

Microscopical diagnosis of tubercle.—Grapes; eight sections; fibrosis and miliary tubercle; numerous giant-cells; T.B. x x.

Meat.—In the muscle of the buttock were a large number of opaque yellowish and tough areas. The mass in which they were found was about 6 inches broad by 2 deep. Meat from elsewhere was normal in appearance.

Microscopical examination:

Intercostal muscles.—Nine sections; normal.

Rump.—Seven sections showed some hæmorrhage between fibres; otherwise normal; 38 sections showed interstitial fibrosis, advanced and destroying muscle fibre; no caseation; no tubercle bacilli.

COW 20.

Killed August 4th, 1891.

Post-mortem examination.

Serous membranes:
1. *Pleuræ.*—A few "grapy" masses in the lower part, with ecchymoses.
2. *Peritoneum.*—Miliary tubercles over the liver and spleen.
3. *Pericardium.*—Normal.

Organs:
1. *Lungs.*—Showed numerous large scattered patches of yellow tubercle, and some areas of softening.

2. *Liver.*
3. *Spleen.*
4. *Heart.*
5. *Kidneys and adrenals.* } Normal.
6. *Udder.*—The posterior lobes were greatly enlarged, and were one very tough mass of yellow tubercle. The anterior lobes were normal in some parts, in others infiltrated with tubercle. There were no abscesses. The sinuses contained a somewhat turbid serous fluid.

Intestinal tract.—The *ileum* showed a tubercular ulcer near the cæcum, and deposit of tubercle in the mucous membrane. The rest of the gut was not examined.

Lymph glands :

1. *Bronchial.*—Very large; showed old calcareo-caseous deposit and recent tubercle.
2. *Glands below diaphragm.*—Showed recent tubercle.
3. *Mesenteric.*—Enormously enlarged; showed both recent and calcareous tubercle.
4. *Lumbar.*—One enlarged on each side; tubercle.
5. *Popliteal.*—Not greatly enlarged; showed doubtful miliary tubercle in cortex.

Microscopical diagnosis of tubercle :

Udder.—Eight sections; caseous tubercle; T.B. xxx; all alveolar structure gone.

Udder duct.—Six sections; caseous tubercle; T.B. xxx; duct contains T.B. xxx; caseous tubercle of duct walls.

Mesenteric gland.—Six sections; advanced caseous tubercle; T.B. xxx.

Popliteal gland.—Normal lymph gland tissue; no caseation; no tubercle bacilli.

Meat.—Normal in appearance; no visible tubercle; 10 cover-slip preparations were made of the meat-juice from the rump, 10 from the breast-muscle, and 10 from the diaphragm; no tubercle bacilli were found. *Rump*, nine sections; normal.

COW 21.

Killed 8th February, 1892. (Post-mortem notes supplied by Dr. Woodhead.)

ost-
ortem ex-
mination.

Serous membranes. Pleuræ.—There was well-marked pleurisy, especially on the upper surface of the diaphragm.

Organs :

Lungs.—Tubercular.

Liver,
Spleen,
Kidneys,
Pancreas, } were all quite normal.

Uterus was very much congested, and there were numerous small yellow patches occupying the position of the cotyledons.

Intestines :

The mucous membrane of both the *large and small gut* was very much congested, and a series of small tuberculous ulcers could be traced throughout both.

The *cæcum* also showed a number of small round tuberculous ulcers.

Cœcal.—Considerably enlarged.

Lumbar.—Enormously enlarged and caseous.

Mesenteric.—Enlarged and tuberculous.

Glands round uterus.—Enormously enlarged and caseous.

Supra-mammary glands.—Enormously enlarged and caseous on the left side; caseous, but not so greatly enlarged, on the right side.

Udder.—Distinctly tubercular. Near last teat on the left side of the udder a series of large cavities containing serous fluid, lined with soft caseous material, had taken the position of the reservoirs. This quarter of the udder was enormously enlarged, and was caseous. There were large tubercular masses in various stages of growth. The right posterior quarter was also tubercular; the two anterior quarters showed nothing abnormal to the naked eye.

Miscroscopical examination :—Udder :

Left posterior quarter.—Six sections; advanced caseous tubercle; T.B. xxxx; no normal gland tissue left.

Right posterior quarter.—Ten sections; showed the same appearances as left posterior quarter.

Left anterior quarter.—Nine sections; in three of these one miliary tubercle was seen, and one tubercle bacillus.

Right anterior quarter.—Thirteen sections; no tubercle present, but some interstitial small-celled infiltration.

Meat.—No visible tubercle.

Miscroscopical examination.—*Fore-quarter*, nine sections; normal.

COW 22.

Killed and examined at Harrow, July 26th, 1892. The animal was very much wasted.

Post-
morte
aminat

Serous membranes :

(i.) *Pleuræ.*—The pleuræ showed "grapes" both on their visceral and parietal surfaces; they were most numerous, and of largest size at the bases of the lungs.

(ii.) *Peritoneum.*—Somewhat slimy to the touch. "Grapes" were to be seen attached to the peritoneum at the brim of the true pelvis, in the pouch of Douglas, on the utero-vesical ligament, on the under surface of the central tendon of the diaphragm, and on the anterior surface of the stomach.

(iii.) *Pericardium.*—Normal.

Organs :

(i.) *Lungs.*—The greater part of both lower lobes consisted of caseous material. Very little of the lung tissue anywhere was free from miliary tubercles.

(ii.) *Liver.*—Normal on section; a few "grapes" were attached to its anterior and lateral borders.

(iii.) *Spleen.*—Normal on section; showed on its outer surface a few "grapes."

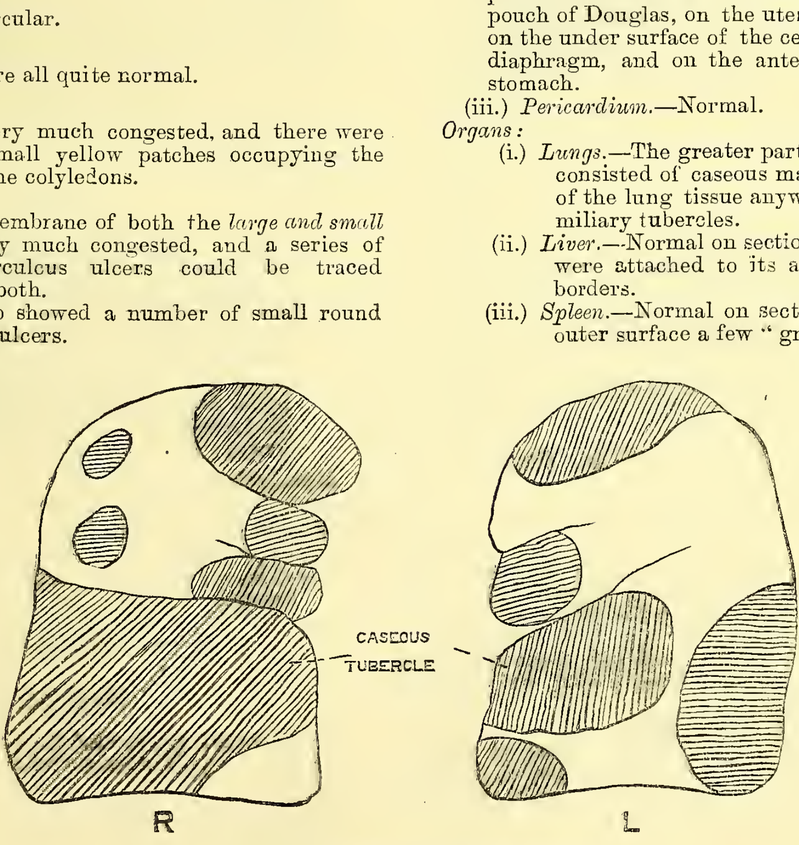

Fig. 9. Diagram of Lungs of Cow 22.

The *stomach* was normal.

Lymph glands :

Bronchial.
Mediastinal. } Very much enlarged and caseous.

(iv.) *Kidneys.*—Large, and showed in their cortices numerous miliary tubercles commencing to caseate.

(v.) *Suprarenals,*
(vi.) *Vagina,*
(vii.) *Ovaries,* } were quite normal.
(viii.) *Thyroid,*
(ix.) *Udder,*

(x.) *Uterus.*—Enlarged and walls thickened. The whole of the mucous membrane of the organ was replaced by a firmly adherent dirty-yellowish material, very like the caseous matter of the glands.

Lymph glands:

Anterior mediastinal.
Bronchial. } Very greatly enlarged; caseous almost throughout, and almost all calcifying.
Posterior mediastinal.

Mesenteric.—Every gland was affected with tubercle, some few were reddened, softened, and becoming caseous; but the great majority showed very little gland structure, and were beginning to calcify.

The cervical, cœliac, iliac, lumbar, supra-mammary, and the popliteal glands, and the glands in the lesser omentum, and around the pylorus, were quite normal.

Intestines:

The *small intestines* contained tubercles in all stages of ulcerating, caseating, and calcifying. They were most numerous in the Peyer's patches.

The *cæcum* contained a few tubercular ulcers, and there was some slight deposit of tubercle in the large intestine.

(4.) *Kidneys.*—There were a few small tubercles in the cortex.

(5.) *Uterus.*—Cornua adherent. No evident tubercle of the mucous membrane or of the cotyledons.

(6.) *Suprarenals.*—Quite normal.

(7.) *Heart.*—Normal.

(8.) *Udder.*—All four quarters and teats were normal.

Lymph glands:

Anterior mediastinal.
Bronchial. } All the glands were greatly enlarged and showed caseo-calcareous tubercle on section.
Posterior mediastinal.

Mesenteric.—Fourteen of these glands were affected with tubercle, for the most calcifying. A gland at the angle of the scapula was caseous.

The cœliac, lumbar, pelvic, supra-mammary, and popliteal glands and the glands in the lesser omentum were quite normal.

Intestines.—There was a small nodule about the middle of the ileum, projecting from the mucous membrane; otherwise the intestines both large and small were quite normal.

Microscopical examination:

Lung.—Ten sections; peribronchial and peri-arterial small-celled infiltration; cell degeneration in parts; no caseation; no tubercle bacilli.

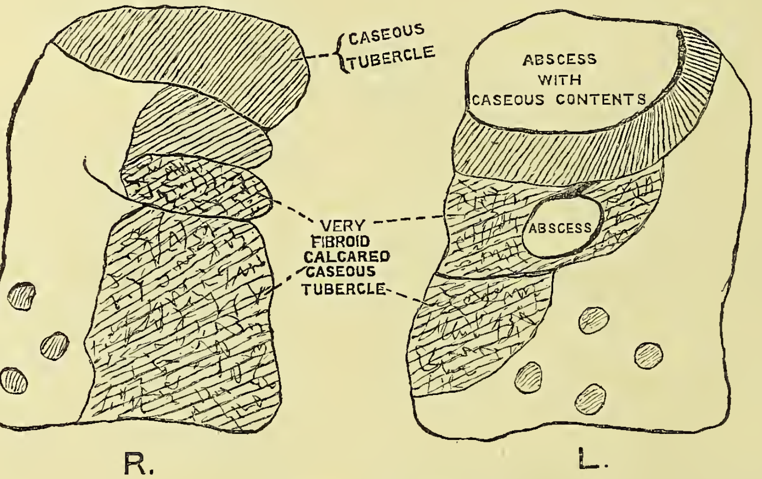
CASEOUS TUBERCLE
ABSCESS WITH CASEOUS CONTENTS
ABSCESS
VERY FIBROID CALCARED CASEOUS TUBERCLE
R.
L.

Figure 10. Diagram of Lungs of Cow 23.

Microscopical examination:

Kidney.—Ten sections; caseous tubercle; tubercle bacilli.

Udder.—Ten sections; normal.

Uterus.—No tubercular structure; no tubercle bacilli; not tubercular.

Posterior mediastinal gland.—Four sections; caseous tubercle; T.B.

Meat.—No visible tubercle.

Microscopical examination.—*Rump,* nine sections; normal.

COW 23.

ost-mortem ex- mination.

Killed and examined at Harrow, February 17th, 1893. The animal was extremely emaciated, there was very little fat, and the carcase was very wet.

Serous membranes:

(i.) *Pleuræ.*—The visceral and parietal surfaces of both pleuræ were thickly covered with "grapes."

(ii.) *Pericardium.*—Normal.

(iii.) *Peritoneum.*—The under surface of the diaphragm, the parietal peritoneum, the great omentum, and the mesentery were thickly covered with "grapes"

Organs:

(1.) *Lungs.*

(2.) *Liver.*—"Grapes" and adhesions on its peritoneal surface; no evident tubercle in its substance.

(3.) *Spleen.*—"Grapes" on the outer surface; Malpighian corpuscles enlarged.

"*Grapes.*" Nine sections; advanced caseous tubercle with extensive fibrosis; T.B. x.

Uterus.—Fourteen sections; normal.

Udder.—Left anterior quarter, 11 sections; normal. Left posterior quarter (near sinus), 11 sections; connective tissue with collections of cells; no udder tissue to be seen. Right anterior quarter, nine sections; normal. Right posterior quarter, nine sections; normal.

Meat.—Very dark in colour, but some parts of the rump were pale and moist; no visible tubercle.

Microscopical examination:

Rump.—Thirteen sections; normal.

Intercostals with pleura attached.—Eleven sections; normal.

COW 24.

Post-mortem examination November 13th, 1891. The animal was very thin and emaciated.

Serous membranes:

Pleuræ.—There was some light inflammation of the pleura over the right lower lobe (not tubercular).

Pericardium.—There was some organising plastic pericarditis; no evident tubercle.

Peritoneum.—The great omentum showed on its surface a gelatinous exudation looking like early grapes.

Organs :

(i.) *Lungs.*—There was some pneumonic consolidation in parts; no caseous tubercle, but a few miliary granulations were seen.

(ii.) *Kidneys.*—The left kidney showed on section three hard caseous areas softening in the centre at the apices of three pyramids. The right showed four similar patches, and there were some scattered miliary tubercles in both kidneys.

(iii.) *Suprarenals.*—Both were infiltrated, and almost completely destroyed by hard yellow caseating tubercle.

(iv.) *Uterus and vagina.*—The vulva was inflamed and excoriated. The os uteri showed a small raised nodule. Both horns of the uterus showed tubercular deposits. One was greatly enlarged with thickened walls infiltrated with nodules of yellow caseous tubercle, and with projecting nodules beneath the mucous membrane, which was deeply congested. The cavity of the horn contains a thick yellow material containing numerous tubercle bacilli. There was no ulceration.

(v.) *Ovaries.*—Not enlarged. Both showed on section a few small foci of caseous tubercle.

(vi.) *Heart,*
(vii.) *Liver,*
(viii) *Spleen,*
(ix.) *Pancreas,*
} were all free from tubercle.

Lymphatic glands :

Bronchial.—Enlarged, hard, pigmented with a few foci of caseous tubercle.

Posterior mediastinal.—Greatly enlarged; tubercular.

Mesenteric.—All enlarged and caseous.

Cœliac.—Enlarged; caseo-calcareous tubercle.

Cœcal.—Enlarged and caseous.

Supra-mammary.—Normal in appearance on left side; enlarged and hard on right.

Pelvic.
Lumbar.
} Greatly enlarged and caseous.

Intestines.—The small intestine showed no tubercle.

Udder.—The right quarters were enlarged to about twice their normal size; on section they were very tough. There was no evident congestion or tubercle. The left quarters were slightly enlarged, but normal on section.

Microscopical examination :

Cover-slip preparations of the vaginal discharge showed tubercle bacilli.

Right udder.—Twelve sections: sparsely scattered caseating tubercle; T.B. xxx.

Left udder.—Fourteen sections; eight sections showed a tubercular structure with giant-cells, but no tubercle bacilli, and six sections contained T.B. x.

Right supra-mammary gland. — Eight sections; eight sections were normal, but other sections showed sparsely scattered miliary tubercles with giant-cells and T.B. x.

Uterus.—Four sections showed caseating tubercle, T.B. xxxx.

Vagina.—Six sections; no tubercle.

Ovary.—Eight sections; no tubercle.

COW 25.

Killed and examined at Balham, May 18th, 1893. The animal was greatly emaciated. The muscles were flabby and dark in colour, and the subcutaneous tissues were very œdematous.

Serous membranes :

Pleuræ.—Some slightly developed "grapes" were present on the right pleura. They were most numerous at the base.

Pericardium.
Peritoneum.
} "Soapy," but otherwise normal.

Organs :

Lungs.—The left lung showed some collections of miliary tubercles in its upper lobes; and the lower lobe consisted almost entirely of miliary tubercles cascating.

The right lung contained in its lower lobe numerous caseous masses. There was very little normal lung tissue remaining. The upper lobes were practically normal.

Liver.—Contained several nodules of caseo-calcareous tubercle of about the size of walnuts.

Kidneys.—Right kidney showed well-marked tubercle in the cortex, running along the lines of the vessels.

The left kidney showed one or two small white tubercles just beneath the cortex.

Uterus.—The right horn of the uterus contained in its wall a hard mass of tubercle, commencing to break down. The mucous membrane of the uterus was intact over the mass. Left horn was normal.

Spleen,
Ovaries,
Cervix uteri,
Vagina,
Suprarenals,
} were all normal.

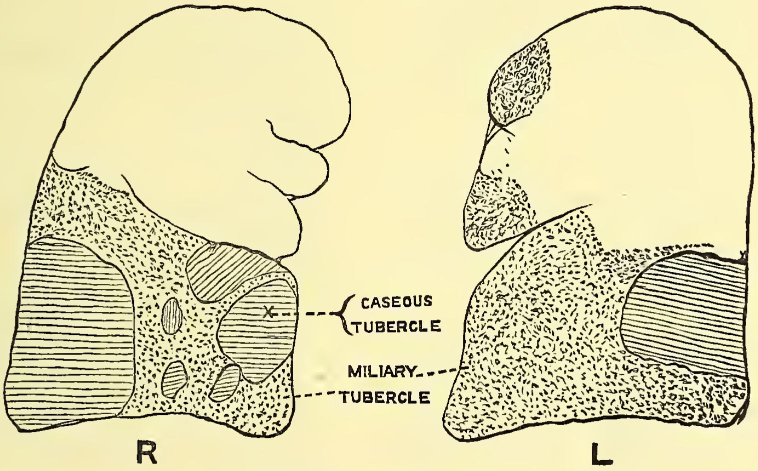

Fig. 11. Diagram of lungs of Cow 25.

Lymph glands :

Anterior mediastinal.—Enlarged, and showed caseo-calcareous tubercle.

Posterior mediastinal.
Bronchial.
} Greatly enlarged, and full of softened caseous tuberculous matter.

Cœliac.—Slightly enlarged, and showed some points of caseous tubercle.

Mesenteric. — All the mesenteric glands were greatly enlarged, and showed gritty tubercle on section.

Popliteal,
Lumbar,
Cervical,
} were normal.

Glands in the lesser omentum were enlarged, and showed gritty tubercle on section.

Glands at the angle of the jaw were normal.

The salivary glands, tongue, tonsils, and larynx were normal. The mesentery was extremely œdematous, and the bone marrow was very gelatinous and watery, with hæmorrhagic points.

Intestines.—Small gut; about 35 well marked ulcers (varying in size from a millet seed to a haricot bean) were seen. They were chiefly met with in the lower part of the ileum.

Large gut was quite normal.

Cæcum contained one or two nodules of tubercle, showing commencing caseation in their centre.

Udder.—The right half of the udder was much larger than the left. Both the anterior and posterior quarters on the right side showed numerous nodules of tubercle, which were breaking down, and forming large cavities with ragged walls containing softened caseous matter. There was a large cavity with caseous contents at each extremity of the right half of the udder.

In the left half of the udder were seen several small yellow points ($\frac{1}{4}$ inch in diameter), surrounded by a dense fibrous tissue. The ducts and sinuses leading to the teats were normal in all quarters.

Supra-mammary glands.—Enlarged and showed deposits of caseo-calcareous tubercle. The right showed more advanced tubercle than the left.

Microscopical examination of udder:

Right posterior quarter.—Nine sections; caseous tubercle; T.B. xxx; only here and there indications of the acini of the gland.

Right anterior quarter.—Ten sections; caseous tubercle; T.B. xxxx; no structure of udder left.

Left anterior quarter.—Fourteen sections; caseous tubercle; T.B. xxx; in parts normal acini and ducts were seen.

Left posterior quarter.—Ten sections; caseous tubercle; T.B. xxx; more normal udder tissue than in left anterior quarter.

The two left quarters were, therefore, less diseased than the two right.

Meat showed no naked eye tubercle on section.

Cows in which Tuberculosis was not found, but in which there was Non-tuberculous Disease of the Udder, 2.

The milk of these cows was used for experiment.

COW 26.

Killed and examined at Harrow, January 25, 1893.

Serous membranes:

(i.) *Pleuræ*,
(ii.) *Peritoneum*, } were all quite normal.
(iii.) *Pericardium*,

Organs:

(i.) *Lungs.*—The right lung contained a parasitic cyst, otherwise they were quite normal.
(ii.) *Liver*,
(iii.) *Spleen*,
(iv.) *Kidneys*, } were all normal.
(v.) *Suprarenals*,
(vi.) *Uterus and ovaries*,

Lymph glands.—The *bronchial*, *mediastinal*, *cœliac*, *lumbar*, *popliteal*, *supra-mammary*, and *mesenteric* glands, and the glands at the *angle of the jaw*, and those in the *lesser omentum* were all quite normal.

Intestines.—Seven yellow nodules were seen in the Peyer's patches towards the middle of the ileum, and two calcareous nodules were found higher up in the mucous membrane of the gut.

Udder.—The two right quarters were larger than the left, and were full of milk, and on section they were perfectly normal. The mucous membrane of their teats was also normal.

The left anterior quarter was for the most part normal. There were one or two doubtful hard and yellowish areas near the junction with the left posterior quarter, but there was no evident tubercle. The teat of this quarter was normal.

The left posterior quarter was small and uniformly hard; on section it was yellowish-brown in colour, with numerous minute yellowish areas. There was no evident tubercle. The mucous membrane of the teat was covered with numerous small warts of 1–2 mm. in diameter.

Microscopical examination.—*Intestinal nodule.*—Twenty-nine sections; showed a nodule in a solitary gland with connective tissue around it. The centre of the nodule showed degenerated cells with degenerated nuclei. No tubercle bacilli; not tubercular.

Udder:

Right anterior quarter.—Nine sections, normal, in one or two parts were some small areas with an increase of the interstitial connective tissue; no tubercle bacilli; no caseation; not tubercular.

Right posterior quarter.—Twelve sections; normal.

Left anterior quarter at its junction with the *left posterior.*—Nine sections. An interstitial small round-celled infiltration, proliferation of the acinous cells; no caseation; no tubercle bacilli; inflammatory.

Left posterior quarter.—Six sections showed a small-celled infiltration obliterating the acini; no tubercle bacilli; inflammatory.

Teat of the left posterior quarter.—Six sections showed papillomata of the mucous membrane of the teat; no tubercle bacilli.

COW 27.

Killed and examined February 28th, 1893.

The cow was fat and well nourished. Meat firm and of good colour.

Serous membranes:

(i.) *Pleuræ.*—A few adhesions on the left pleura, otherwise normal.
(ii.) *Pericardium.* } Quite normal.
(iii.) *Peritoneum.*

Between the pleural and peritoneal coverings of the diaphragm on the right side, an abscess about 4 inches in diameter was found. The inner lining of the wall was somewhat ragged, but outside this there was an abundant overgrowth of connective tissue. The contents were muco-purulent, and were not offensive. A small calcified mass, about the size and shape of a hazel nut, was found inside the abscess.

Organs:

(i.) *Lungs.*—The left lung showed a thickened and inflamed pleura at its base where it had been in contact with the abscess. No tubercle.
(ii.) *Liver*,
(iii.) *Spleen*,
(iv.) *Kidneys*,
(v.) *Suprarenals*, } were all quite normal.
(vi.) *Uterus*,
(vii.) *Vagina*,
(viii.) *Ovaries*,

Lymphatic glands.—All the lymphatic glands were normal.

Intestine.—The small gut showed two small solitary glands enlarged and hardened, calcareous on section.

Udder.—Left posterior quarter most remote from the teat was normal, whereas that part of the quarter nearest to the teat was more fibrous, and contained several yellow nodules.

In the two anterior quarters and the right posterior quarter numerous yellow nodules were to be seen, especially round the teats. The gland tissue was very fibrous.

The teats and large ducts were normal.

Microscopical examination.—Six cover-slip preparations were made of the contents of the abscess. No tubercle bacilli.

Udder.—*Right posterior quarter.*—Nine sections; advanced interstitial mastitis; no caseation; no tubercle bacilli; not tubercular.

Left anterior quarter.—Nine sections; advanced interstitial mastitis; no caseation; no tubercle bacilli; not tubercular.

Left posterior quarter.—Six sections; in parts some small-celled infiltration; in other parts cells in a state of secreting activity; no caseation; no tubercle bacilli; not tubercular.

Right anterior quarter.—Thirteen sections; small-celled infiltration compressing acini; cells not in a state of secreting activity; no caseation; no tubercle bacilli; not tubercular.

INQUIRY II.

PART VI.

Containing the previous history of the milch cows used in the investigation; with a record of the physical examination of the animals, and of the rectal temperature.

The analyses and microscopical examination of the milk are given in Part III. of the Report.

The cows are arranged in numerical order, and bear the same numbers throughout the Report.

COW 7.

General tuberculosis; udder normal.

Arrived at Harrow October 22nd, 1892.

History.—The cow was nine years old, had had several calves, and had been "failing" since the winter of 1891-2. The milk had been sold up to the date of her purchase by the Royal Commission.

On arrival at Harrow the cow was noticed to be thin, suffering from diarrhœa, and had a slight cough. The udder was small, but quite normal.

The cow was under observation for 31 days.

Quantity of Milk given by the Cow.

Date.	Morning.	Date.	Morning.
1892.		1892.	
October 23	600 cc.	November 5	550 cc.
" 24	560 cc.	" 6	370 cc.
" 25	400 cc.	" 7	600 cc.
" 26	400 cc.	" 8	500 cc.
" 27	750 cc.	" 9	580 cc.
" 28	750 cc	" 10	300 cc.
" 29	650 cc.	" 11	500 cc.
" 30	700 cc.	" 12	250 cc.
" 31	700 cc.	" 13	550 cc.
November 1	650 cc.	" 14	200 cc.
" 2	450 cc.	" 15	200 cc.
" 3	620 cc.	" 16	150 cc.
" 4	800 cc.	" 17	100 cc.

Temperature of Cow.

1892.		F.
October 25	9 a.m.	102·4°.
	1 p.m.	102°.
	5 p.m.	103°.
	9 p.m.	102·4°.
October 26	9 a.m.	101·2°.
	1 p.m.	101·4°.
	5 p.m.	101°.
	9 p.m.	102·4°.
October 27	9 a.m.	102·8°.
	1 p.m.	102·2°.
	5 p.m.	102°.
	9 p.m.	102·6°.
October 28	9 a.m.	103°.
	1 p.m.	102·6°.
	5 p.m.	102·4°.
	9 p.m.	102°.
October 29	9 a.m.	103·4°.
	1 p.m.	103·4°.
	5 p.m.	102·8°.
	9 p.m.	102·6°.
October 30	9 a.m.	102·6°.
	1 p.m.	102·8°.
	5 p.m.	103°.
	9 p.m.	103°.
October 31	9 a.m.	102·6°.
	1 p.m.	103°.
	5 p.m.	101·4°
	9 p.m.	102°.

COW 8.

Tuberculosis of internal organs and of udder.

Arrived at Harrow October 26th, 1892.

History.—She was purchased in Bristol Market in September 1891. At that time she had recently calved, and had an "uneven bag." She had been in milk since that date.

On April 18th, 1892, her left posterior teat was amputated for acute mastitis of the corresponding quarter into which the knife was thrust. This was followed by a continuous discharge for many weeks. The other quarters of the udder were normal, but the left anterior quarter was somewhat hard.

On arrival at Harrow (October 26th, 1892) the cow was somewhat emaciated, but there was no cough. In the left posterior quarter of the udder was a large firm mass. There was a discharge from the spot where the teat had been amputated, and there was also an ulcer where an abscess had discharged. The cow was under observation for 28 days.

Quantity of Milk given by the Cow.

Date.	Morning.	Night.
1892.		
October 27	1,550 cc.	660 cc.
" 28	800 cc.	400 cc.
" 29	920 cc.	Not milked.
" 30	980 cc.	"
" 31	950 cc.	"
November 1	1,000 cc.	"
" 2	880 cc.	"
" 3	900 cc.	"
" 4	720 cc.	"
" 5	1,200 cc.	"
" 6	1,050 cc.	"
" 7	950 cc.	"
" 8	1,150 cc.	"
" 9	720 cc.	"
" 10	930 cc.	"
" 11	830 cc.	"
" 12	650 cc.	"
" 13	820 cc.	"
" 14	580 cc.	"
" 15	500 cc.	"
" 16	620 cc.	"
" 17	600 cc.	"
" 18	470 cc.	"
" 19	250 cc.	"
" 20	510 cc.	"
" 21	500 cc.	"

Temperature of Cow.

1892.		F.
October 28	1 p.m.	102·4°.
	5 p.m.	101·4°.
	9 p.m.	101·4°.
October 29	9 a.m.	101·8°.
	1 p.m.	102·8°.
	5 p.m.	101·2°.
	9 p.m.	101·4°.
October 30	9 a.m.	102·2°.
	1 p.m.	101·8°.
	5 p.m.	102°.
	9 p.m.	102°.
October 31	9 a.m.	101·6°.
	1 p.m.	101°.
	5 p.m.	100·4°.
	9 p.m.	101°.
November 1	9 a.m.	101·3°.
	1 p.m.	102°.
	5 p.m.	101·3°.
	9 p.m.	102·2°.
November 2	9 a.m.	102°.
	1 p.m.	102°.
	5 p.m.	101·8°.
	9 p.m.	102·2°.

COW 11.

General tuberculosis; udder normal.

Arrived at Harrow August 2nd, 1892.

History.—The cow was about 11 years old. She had been bought by a dairyman three years previous to her purchase by the Royal Commission. She had calved three weeks before her arrival at Harrow, and had been ill since this calving, when she probably caught cold. She had had a cough for a very long time.

On arrival at Harrow the cow was not markedly emaciated, but she had a slight cough. The udder was quite normal.

The cow was under observation for 38 days.

Quantity of Milk given by the Cow.

Date.	Morning.	Night.
August 3	4,200 cc.	2,800 cc.
„ 4	4,500 cc.	1,450 cc
„ 5	4,820 cc.	1,900 cc.
„ 6	4,420 cc.	2,000 cc.
„ 7	4,410 cc.	1,680 cc.
„ 8	4,230 cc.	2,140 cc.
„ 9	3,930 cc.	2,250 cc.
„ 10	5,140 cc.	1,700 cc.
„ 11	4,650 cc.	1,210 cc.
„ 12	4,720 cc.	2,050 cc.
„ 13	4,100 cc.	2,200 cc.
„ 14	3,900 cc.	2,750 cc.
„ 15	3,950 cc.	1,080 cc.
„ 16	4,600 cc.	1,850 cc.
„ 17	5,100 cc.	1,810 cc.
„ 18	3,400 cc.	1,860 cc.
„ 19	3,420 cc.	1,700 cc.
„ 20	3,550 cc.	1,830 cc.
„ 21	3,610 cc.	1,460 cc.
„ 22	3,550 cc.	1,600 cc.
„ 23	3,400 cc.	1,860 cc.
„ 24	2,850 cc.	1,720 cc.
„ 25	3,350 cc.	1,600 cc.
„ 26	3,000 cc.	1,520 cc.
„ 27	3,410 cc.	1,370 cc.
„ 28	2,880 cc.	1,500 cc.
„ 29	2,950 cc.	1,150 cc.
„ 30	3,000 cc.	1,120 cc.
„ 31	2,650 cc.	1,500 cc.
September 1	2,850 cc.	650 cc.
„ 2	2,800 cc.	800 cc.
„ 3	2,550 cc.	650 cc.
„ 4	2,310 cc.	1,150 cc.
„ 5	2,470 cc.	1,200 cc.
„ 6	2,470 cc.	1,190 cc.
„ 7*	1,450 cc.	700 cc.
„ 8	1,700 cc.	1,320 cc.

* At 10.20 a.m., September 7th, the cow was inoculated with Koch's Tuberculin.

Temperature of Cow.

1892.		F.
August 9	10 a.m.	103°.
	2 p.m.	104·4°.
	10 p.m.	104·3°.
August 10	10 a.m.	103·2°.
	2 p.m.	104·4°.
	10 p.m.	104°.
August 11	10 a.m.	104·1°.
	2 p.m.	104·3°.
	10 p.m.	105°.
August 12	10 a.m.	104·2°.
	2 p.m.	103°.
	10 p.m.	104·1°.
August 13	10 a.m.	103·2°.
	2 p.m.	104°.
	10 p.m.	104·4°.
August 14	10 a.m.	103·2°.
	2 p.m.	104°.
	10 p.m.	103·4°.
August 15	2 p.m.	103·4°.
	10 p.m.	104·2°.

COW 12.

General tuberculosis; udder normal.

Arrived at Harrow October 3rd, 1892.

History.—She had calved eight or nine times, and had been a good milker. She had always been a healthy cow until a short time before she was purchased by the Royal Commission, when she began to lose flesh very fast, and developed a cough.

On arrival at Harrow the cow was emaciated, refused food, and had a bad cough. The breathing was very short. At the lower part of the udder, just above and behind the right posterior teat, was a small hard freely movable swelling, about the size of a hazel-nut, and more easily felt when the animal had been milked. The rest of the udder was normal. There were no enlarged glands to be felt.

The cow was under observation for 18 days.

Quantity of Milk given by the Cow.

Date.	Morning.	Evening.
October 5	2,000 cc.	300 cc.
„ 6	2,230 cc.	120 cc.
„ 7	1,930 cc.	820 cc.
„ 8	2,200 cc.	230 cc.
„ 9	1,900 cc.	300 cc.
„ 10	1,450 cc.	150 cc.
„ 11	600 cc.	2,200 cc.
„ 12	300 cc.	550 cc.
„ 13	980 cc.	400 cc.
„ 14	550 cc.	300 cc.
„ 15	750 cc.	280 cc.
„ 16	480 cc.	170 cc.
„ 17	490 cc.	150 cc.
„ 18	380 cc.	160 cc.
„ 19*	210 cc.	—

* 10.25 a.m., October 19th, the cow was inoculated with Koch's Tuberculin.

Temperature of Cow.

1892.		F.
October 11	9 a.m.	102·4°.
	1 p.m.	104·2°.
	5 p.m.	104°.
	9 p.m.	104·1°.
October 12	9 a.m.	103°.
	1 p.m.	103·1°.
	5 p.m.	102·3°.
	9 p.m.	104·2°.
October 13	9 a.m.	103°.
	1 p.m.	102·3°.
	5 p.m.	103°.
	9 p.m.	104°.
October 14	9 a.m.	102·3°.
	1 p.m.	103°.
	5 p.m.	103°.
	9 p.m.	104°.
October 15	9 a.m.	103°.
	1 p.m.	102·3°.
	5 p.m.	103°.
	9 p.m.	104·2°.
October 16	9 a.m.	103·2°.
	1 p.m.	103·3°.
	5 p.m.	102·3°.
	9 p.m.	104°.
October 17	9 a.m.	100·3°.
	1 p.m.	102·3°.
	5 p.m.	101°.
	9 p.m.	102°.

COW 13.

General tuberculosis; udder normal.

The cow arrived at Harrow October 22nd, 1892.

History.—She was seven years of age, had had several calves, and had been in bad health for nine months. The milk had been sold up to the time of her purchase by the Royal Commission.

On arrival at Harrow the cow was very thin. No enlarged glands could be detected, and the udder was small and somewhat hard.

The cow was under observation for 20 days.

Quantity of Milk given by the Cow.

Date.	Morning.	Date.	Morning.
1892.		1892.	
October 23	140 cc.	October 28	55 cc.
„ 24	50 cc.	„ 29	50 cc.
„ 25	33 cc.	„ 30	35 cc.
„ 26	40 cc.	„ 31	36 cc.
„ 27	45 cc.	November 1	35 cc.

Temperature of Cow.

1892.		F.
October 25	9 a.m.	103·4°.
	1 p.m.	102·4°.
	5 p.m.	102·3°.
	9 p.m.	101·2°.
October 26	9 a.m.	102·4°.
	1 p.m.	101°
	5 p.m.	101·6°.
	9 p.m.	102·2°.

1892.		F.
October 27	9 a.m.	103·2°.
	1 p.m.	102·6°.
	5 p.m.	101·6°.
	9 p.m.	102·4°.
October 28	9 a.m.	102·4°.
	1 p.m.	103°.
	5 p.m.	102°.
	9 p.m.	102°.
October 29	9 a.m.	102·6°.
	1 p.m.	102°.
	5 p.m.	102·2°.
	9 p.m.	102·4°.
October 30	9 a.m.	101·2°.
	1 p.m.	102°.
	5 p.m.	102·2°.
	9 p.m.	102·4°.
October 31	9 a.m.	102°.
	1 p.m.	102·4°.
	5 p.m.	100°.
	9 p.m.	102·4°.

COW 15.

General tuberculosis; udder normal.

A half-bred Jersey, arrived at Harrow June 28th, 1892.

The cow was about five years of age, and had had four calves, the last about one month before her arrival. She had been losing flesh for some two months.

On arrival the animal was emaciated, with slight diarrhœa and a cough. The udder was normal.

The cow was under observation for 23 days.

Quantity of Milk given by the Cow.

Date.	Morning.	Night.
1892.		
June 29	2,310 cc.	1,100 cc.
„ 30	1,800 cc.	1,550 cc.
July 1	1,950 cc.	1,600 cc.
„ 2	2,300 cc.	1,500 cc.
„ 3	1,850 cc.	1,800 cc.
„ 4	1,750 cc.	1,900 cc.
„ 5	1,450 cc.	1,100 cc.
„ 6	1,415 cc.	1,750 cc.
„ 7	1,050 cc.	1,600 cc.
„ 8	900 cc.	1,650 cc.
„ 9	1,400 cc.	1,600 cc.
„ 10	1,500 cc.	1,000 cc.
„ 11	1,300 cc.	1,300 cc.
„ 12	1,250 cc.	860 cc.
„ 13	850 cc.	1,020 cc.
„ 14	750 cc.	400 cc.
„ 15	680 cc.	450 cc.
„ 16	550 cc.	400 cc.
„ 17	530 cc.	160 cc.
„ 18	330 cc.	200 cc.
„ 19*	180 cc.	120 cc.
„ 20	110 cc.	50 cc.

* At 11 a.m. July 19th the cow was inoculated with Koch's Tuberculin.

Temperature of Cow.

1892.		F.
June 29	2 p.m.	102°.
	10 p.m.	103·2°.
June 30	10 a.m.	103·1°.
	2 p.m.	104·1°.
	10 p.m.	103·4°.
July 1	10 a.m.	103·4°.
	2 p.m.	104·1°.
	10 p.m.	103·3°.
July 2	10 a.m.	103·2°.
	2 p.m.	104·1°.
	10 p.m.	103·4°.
July 3	10 a.m.	104°.
	2 p.m.	105·1°.
	10 p.m.	103·2°.
July 4	10 a.m.	103·2°.
	2 p.m.	105°.
	10 p.m.	102·4°.
July 5	10 a.m.	103·4°.
	2 p.m.	104·1°.
	10 p.m.	103·2°.

COW 16.

General tuberculosis; udder normal.

A Guernsey arrived at Harrow from Veterinary College, May 2nd 1892.

History.—She was bought five or six years ago at the Dairy Show with a calf at foot, and came originally from Southampton. This calf was examined after death at the Veterinary College, and was the subject of tuberculosis. Two years ago a veterinary surgeon said the cow was suffering from tuberculosis, but as she was milking well the dairyman, whose property she was, refused to get rid of her, and bred from her again.

On arrival at Harrow the animal was greatly emaciated, and had a cough. Nothing abnormal was to be felt in the udder, and no lymphatic glands could be felt enlarged.

The cow as under observation for 41 days.

Quantity of Milk given by the Cow.

Date.	Morning.	Night.
1892.		
May 4	3,450 cc.	1,400 cc.
„ 5	3,450 cc.	1,100 cc.
„ 6	2,900 cc.	1,220 cc.
„ 7	2,320 cc.	Not milked.
„ 8	4,900 cc.	„
„ 9	3,620 cc.	„
„ 10	3,730 cc.	„
„ 11	3,670 cc.	„
„ 12	3,620 cc.	„
„ 13	3,820 cc.	„
„ 14	3,450 cc.	„
„ 15	4,600 cc.	„
„ 16	3,750 cc.	„
„ 17	4,000 cc.	„
„ 18	3,720 cc.	„
„ 19	4,380 cc.	„
„ 20	4,300 cc.	„
„ 21	4,220 cc.	„
„ 22	4,100 cc.	„
„ 23	3,350 cc.	„
„ 24	4,020 cc.	1,450 cc.
„ 25	2,900 cc.	1,350 cc.
„ 26	3,030 cc.	1,550 cc.
„ 27	2,800 cc.	1,100 cc.
„ 28	2,550 cc.	1,150 cc.
„ 29	2,900 cc.	700 cc.
„ 30	3,000 cc.	1,300 cc.
„ 31	2,800 cc.	1,380 cc.
June 1	3,000 cc.	1,400 cc.
„ 2	3,350 cc.	1,250 cc.
„ 3	3,050 cc.	1,000 cc.
„ 4	3,200 cc.	1,060 cc.
„ 5	3,300 cc.	930 cc.
„ 6	3,100 cc.	1,250 cc.
„ 7	3,500 cc.	1,230 cc.
„ 8*	3,050 cc.	1,760 cc.
„ 9	3,300 cc.	1,550 cc.
„ 10	2,750 cc.	1,040 cc.
„ 11	2,050 cc.	800 cc.
„ 12	1,970 cc.	700 cc.
„ 13	1,600 cc.	—

* Inoculated June 8, 10 a.m., with Koch's Tuberculin.

Temperature of Cow.

1892.		F.
May 6	10 a.m.	103·1°.
	4 p.m.	101·3°.
	10 p.m.	102·2°.
May 7	10 a.m.	102°.
	4 p.m.	103°.
	10 p.m.	102·1°.
May 8	10 a.m.	101·4°.
	4 p.m.	102°.
	10 p.m.	100·4°.
May 9	10 a.m.	102·1°.
	4 p.m.	102°.
	10 p.m.	102·1°.
May 10	4 p.m.	103°.
	10 p.m.	101·2°.
May 11	10 a.m.	101·4°.
	4 p.m.	102·4°.
	10 p.m.	102·1°.
May 12	10 a.m.	101°.
	4 p.m.	102·2°.
	10 p.m.	102°.

COW 17.

General tuberculosis; inflammation of udder.
Arrived at Harrow February 21st 1893.

History.—She was bought from a cattle dealer by a farmer two months before she was purchased by the Royal Commission. Three weeks previously she calved with two well-nourished twins. The farmer of whom she was purchased professed to know nothing about her history, and thought that her low condition when purchased was due to exposure only.

On arrival at Harrow the cow was emaciated. She had a cough, and there was dulness with gurgling râles at the base of the left lung. The cow was under observation for 30 days.

Quantity of Milk given by the Cow.

Date.	Morning.	Night.
1892.		
February 22	000 cc.	2,000 cc.
„ 23	4,500 cc.	1,300 cc.
„ 24	4,500 cc.	1,000 cc.
„ 25	5,000 cc.	1,400 cc.
„ 26	5,200 cc.	1,100 cc.
„ 27	5,000 cc.	1,200 cc.
„ 28	2,300 cc.	500 cc.
March 1	890 cc.	100 cc.
„ 2	2,500 cc.	Not milked.
„ 3	2,300 cc.	„
„ 4	4,300 cc.	„
„ 5	4,300 cc.	„
„ 6	3,800 cc.	„
„ 7	3,500 cc.	„
„ 8	3,800 cc.	„
„ 9	4,000 cc.	„
„ 10	4,500 cc.	„
„ 11	4,000 cc.	„
„ 12	4,500 cc.	„
„ 13	4,300 cc.	„
„ 14	3,500 cc.	„
„ 15	3,800 cc.	„
„ 16	4,500 cc.	„
„ 17	4,000 cc.	„
„ 18	4,500 cc.	„
„ 19	4,200 cc.	„
„ 20*	2,000 cc.	„
„ 21	3,000 cc.	„
„ 22	3,800 cc.	„
„ 23	3,400 cc.	„

* At 2 p.m., March 20, the cow was inoculated with Koch's Tuberculin.

Temperature of Cow.

1893.		F.
February 26	8 a.m.	101·2°.
	2 p.m.	102·2°.
	10 p.m.	101·6°.
February 27	8 a.m.	100·8°.
	2 p.m.	102°.
	10 p.m.	101·6°.
February 28	8 a.m.	105.4°.
	2 p.m.	105°.
	10 p.m.	102·4°.
March 1	8 a.m.	103°.
	2 p.m.	102.4°.
	10 p.m.	103°.
March 2	8 a.m.	102°.
	2 p.m.	103·8°.
March 3	8 a.m.	102·4°.
	2 p.m.	104°.
	10 p.m.	102·°4.
March 4	8 a.m.	101·°4.
	10 p.m.	102°.

COW 18.

General tuberculosis; inflammation of udder.
Arrived at Harrow February 21st, 1893.

History.—She was bought by a dairyman in Watford Market; at that time she was in calf. She calved six weeks before her purchase by the Royal Commission, and since calving she had been regularly milked. Her illness was said to have been of only a fortnight's duration. On arrival at Harrow, she was found to be in a moribund condition and was slaughtered immediately. Before death the udder was examined, and the left posterior quarter felt hard and nodular. A little milk was drawn off from each quarter.

The cow was under observation for a few hours only.

COW 20.

General tuberculosis; tuberculosis of udder.
Arrived at Harrow July 30th, 1891.

The animal was an adult Guernsey, very thin, weak, and feverish. Râles were to be heard in the chest. The animal refused its food.

The cow was under observation for five days.

COW 21.

General tuberculosis; tuberculosis of udder.

This cow was sent from Copenhagen by Professor Bang, and arrived at Balham December 8th, 1891.

The cow was under Dr. Woodhead's observation for 62 days.

COW 22.

General tuberculosis; udder normal.

A shorthorn cow, arrived at Harrow June 25th, 1892.

No history could be obtained with this cow except that she came out of a dairy.

The cow was emaciated, had slight diarrhœa and a cough.

The teats were studded in several places with small warts, and there was some superficial ulceration of the warty masses in a few places. These had probably been caused by a suckling calf. In the posterior right quarter of the udder was a small hard nodule about the size of a hazel nut. The other quarters of the udder were perfectly normal.

The cow was under observation for 31 days.

Quantity of Milk given by the Cow.

Date.	Morning.	Night.
1892.		
June 26	5,400 cc.	1,450 cc.
„ 27	2,750 cc.	700 cc.
„ 28	3,450 cc.	500 cc.
„ 29	3,150 cc.	1,100 cc.
„ 30	All spilt except 350 cc.	1,800 cc.
July 1	3,050 cc.	1,800 cc.
„ 2	3,200 cc.	1,370 cc.
„ 3	3,450 cc.	800 cc.
„ 4	2,750 cc.	1,700 cc.
„ 5	2,150 cc.	950 cc.
„ 6	2,450 cc.	1,400 cc.
„ 7	2,500 cc.	1,320 cc.
„ 8	2,080 cc.	300 cc.
„ 9	2,500 cc.	350 cc.
„ 10	2,550 cc.	200 cc.
„ 11	1,850 cc.	160 cc.
„ 12	1,550 cc.	460 cc.
„ 13	1,130 cc.	500 cc.
„ 14	1,450 cc.	145 cc.
„ 15	1,330 cc.	500 cc
„ 16	1,350 cc.	600 cc.
„ 17	1,350 cc.	140 cc.
„ 18	780 cc.	250 cc.
„ 19*	450 cc.	300 cc.
„ 20	510 cc.	200 cc.
„ 21	200 cc.	Not milked.
„ 22	120 cc.	„
„ 23	125 cc.	„
„ 24	100 cc.	„
„ 25	60 cc.	„

* At 11 a.m. July 19th, the animal was inoculated with Koch's Tuberculin.

Temperature of Cow.

1892.		F.
June 29	10 a.m.	101°.
	2 p.m.	101·2°.
	10 p.m.	101·3°.
June 30	10 a.m.	103°.
	2 p.m.	103°.
	10 p.m.	103·2°.
July 1	10 a.m.	102·3°.
	2 p.m.	103·4°.
	10 p.m.	103·1°.
July 2	10 a.m.	102·3°.
	2 p m.	103·2°.
	10 p.m.	104·1°.
July 3	10 a.m.	103·2°.
	2 p.m.	104·3°.
	10 p.m.	102·3°.
July 4	10 a.m.	103°.
	2 p.m.	104·2°.
	10 p.m.	103·2°.
July 5	10 a.m.	102·4°.
	2 p.m.	103·4°.
	10 p.m.	103·1°.

COW 23.

General tuberculosis; udder normal.

Arrived at Harrow January 13, 1893.

History.—The animal was a young cow, and had her first calf in September, 1892. The milk bad been used for consumption, but this was protested against by the Urban Sanitary Authority. The cow was then sold by the dairyman to a cattle-dealer, from whom it was purchased by the Royal Commission.

On arrival at Harrow the cow was emaciated, aud had a bad cough. There was dulness at both bases of the lungs and mucous râles and crepitations were heard on auscultation.

The cow was under observation for 35 days.

Quantity of Milk given by the Cow.

Date.	Morning.	Date.	Morning.
1893.		1893.	
January 13	1,700 cc.	January 31	2,200 cc.
„ 14	420 cc.	February 1	1,800 cc.
„ 15	750 cc.	„ 2	1,800 cc.
„ 16	1,125 cc.	„ 3	1,700 cc.
„ 17	1,700 cc.	„ 4	1,650 cc.
„ 18	2,000 cc.	„ 5	1,740 cc.
„ 19	1,800 cc.	„ 6	1,800 cc.
„ 20	2,000 cc.	„ 7	1,420 cc.
„ 21	1,500 cc.	„ 8	1,780 cc.
„ 22	2,100 cc.	„ 9	1,820 cc.
„ 23	2,100 cc.	„ 10	1,790 cc.
„ 24	2,100 cc.	„ 11	1,800 cc.
„ 25	2,150 cc.	„ 12	1,910 cc.
„ 26	2,300 cc.	„ 13	1,850 cc.
„ 27	1,900 cc.	„ 14	1,800 cc.
„ 28	1,800 cc.	„ 15	1,560 cc.
„ 29	2,200 cc.	„ 16	1,490 cc.
„ 30	1,800 cc.	„ 17	1,480 cc.

Temperature of Cow.

1893.		F.
January 13	9 p.m.	102·4°.
January 14	9 a.m.	102·4°.
	1 p.m.	103·6°.
	5 p.m.	102·6°.
	9 p.m.	101·8°.
January 15	9 a.m.	99·4°.
	1 p.m.	103·8°.
	5 p.m.	104·8°.
	9 p.m.	102°.
January 16	9 a.m.	103·6°.
	1 p.m.	103·4°.
	5 p.m.	102°.
	9 p.m.	103·2°.
January 17	9 a.m.	103°.
	1 p.m.	104°.
	5 p.m.	103°.
	9 p.m.	102·8°.
January 18	9 a.m.	103·2°.
	1 p.m.	104°.
	5 p.m.	100·6°
	9 p.m.	102·6°.
January 19	9 a.m.	103°.
	1 p.m.	101·6°.
	5 p.m.	103°.
	9 p.m.	102°.
January 20	9 a.m.	102·6°.
	1 p.m.	104·2°.
	5 p.m.	98·4°.
	9 p.m.	103·6°.

COW 24.

General tuberculosis; tuberculosis of udder.

The animal was sent up from Edinburgh by Professor Whalley. It was kept at the Veterinary College, and examined October 12, 1891.

The cow was ill, emaciated, and had a slight cough.

There was no diarrhœa, and the appetite was fairly good.

The cow was bought in the market at Edinburgh, and no history could be obtained.

The cow was under observation for 32 days.

COW 25.

General tuberculosis; tuberculosis of udder.

Arrived at Harrow January 19th, 1893.

History.—The animal was purchased from a cattle-dealer and the only history obtainable was that she came out of a dairy.

On arrival at Harrow it was noticed that the cow had a good deal of cough, and there was dulness at the base of the right lung.

The cow was under observation for 119 days.

Quantity of Milk given by the Cow.

Date.	Quantity.	Date.	Quantity.
1893.		1893.	
January 19	390 cc.	February 14	490 cc.
„ 20	900 cc.	„ 15	420 cc.
„ 21	1,230 cc.	„ 16	470 cc.
„ 22	1,000 cc.	„ 17	460 cc.
„ 23	1,000 cc.	„ 18	470 cc.
„ 24	750 cc.	„ 19	510 cc.
„ 25	620 cc.	„ 20	480 cc.
„ 26	850 cc.	„ 21	490 cc.
„ 27	650 cc.	„ 22	480 cc.
„ 28	550 cc.	„ 23	470 cc.
„ 29	600 cc.	„ 24	510 cc.
„ 30	510 cc.	„ 25	500 cc.
„ 31	580 cc.	„ 26	430 cc.
February 1	540 cc.	„ 27	480 cc.
„ 2	490 cc.	„ 28	420 cc.
„ 3	510 cc.	March 1	440 cc.
„ 4	500 cc.	„ 2	435 cc.
„ 5	540 cc.	„ 3	420 cc.
„ 6	490 cc.	„ 4	410 cc.
„ 7	500 cc.	„ 5	400 cc.
„ 8	640 cc.	„ 6	270 cc.
„ 9	550 cc.	„ 7	380 cc.
„ 10	510 cc.	„ 8	390 cc.
„ 11	490 cc.	„ 9	350 cc.
„ 12	420 cc.	„ 10	320 cc.
„ 13	480 cc.		

Temperature of Cow.

1893.		F.
January 19	5 p.m.	102°.
January 20	9 a.m.	101·8°.
	1 p.m.	101·4°.
	5 p.m.	102·4°.
	9 p.m.	102·6°.
January 21	9 a.m.	102·6°.
	1 p.m.	101·8°.
	5 p.m.	102·6°.
January 22	9 a.m.	102°.
	1 p.m.	102·6°.
	5 p.m.	103°.
January 23	9 a.m.	101°.
	1 p.m.	101·4°.
	5 p.m.	102°.
	9 p.m.	101·6°.

1893.		F.
January 24	9 a.m.	102°.
	1 p.m.	101·8°.
	5 p.m.	101°.
	9 p.m.	101·8°.
January 25	9 a.m.	101·4°.
	1 p.m.	102°.
	5 p.m.	100·8°.
	9 p.m.	101·6°.
January 26	9 a.m.	101·8°.
	1 p.m.	102·6°.
	5 p.m.	102·2°.
	9 p.m.	101·4°.

COW 26.

No tuberculosis; non-tuberculous disease of the udder.

Arrived at Harrow December 5th, 1892.

The animal was born in June, 1888, of a half-bred Jersey cow by a shorthorn bull. She had two calves, and was "sickly" after the birth of the first, but recovered. After the birth of the second, which took place in July, 1892, she wasted, and suffered from mammitis, affecting the two left quarters. She was milked up to the time of her purchase, but the milk was said not to have been used for human consumption.

On arrival at Harrow the cow was seen to be rather thin, but she had no cough, no diarrhœa, and the breathing was normal. On auscultation a few coarse and some crepitant râles were to be heard at the base of the left lung.

Udder.—The left posterior quarter was occupied by a hard mass, and the posterior part of the left anterior quarter was also felt to be harder than normal. The right posterior quarter was somewhat harder than normal, but not so markedly as on the left side. The right anterior quarter was normal.

The glands behind the udder were not enlarged.

Microscopical examination of the milk:—

December 10.—10 cover-slip preparations of the milk from all quarters. No tubercle bacilli.

December 14.—10 cover-slip preparations of the milk from left posterior quarter. Two preparations showed some doubtful tubercle bacilli.

December 15.—10 cover-slip preparations of the milk from the left anterior quarter. No tubercle bacilli.

December 15.—10 cover-slip preparations of the milk from the right posterior quarter. No tubercle bacilli.

December 15.—10 cover-slip preparations of the milk from the right anterior quarter. No tubercle bacilli.

MILK ANALYSIS, December 15th, 1892.

Milk from the different quarters were tested.

All samples clotted normally with rennet in half a minute, except the milk from the left posterior quarter, which remained quite fluid.

Milk from *left posterior quarter*, December 13th, 1892.

Slightly alkaline. Yellowish in colour. Deposit = 28 vols per cent. Did not clot with rennet; but, being placed in an incubator at 38° for 12 hours, a few clots formed and floated.

Specific gravity.—1029.

Cream.—1·5 vols per cent.

Lactose.—2·81 g. per cent.

Ash.—0·70 g. per cent.

Total solids.—10·85 g. per cent.

Milk from *left anterior quarter*, December 15th, 1892.

Normal colour. No deposit. Clots normally with rennet.

Specific gravity.—1033.

Cream.—3 vols per cent.

Lactose.—4·22 g. per cent.

Ash.—0·85 g. per cent.

Total solids.—11·25 g. per cent.

Milk from *right posterior quarter*, December 15th, 1892.

Normal colour. No deposit. Clots normally with rennet.

Specific gravity.—1035.

Cream.—2 vols per cent.

Lactose.—6·145 g. per cent.

Ash.—0·80 g. per cent.

Total solids.—11·00 g. per cent.

Milk from *right anterior quarter*, December 13th, 1892.

Normal colour. Slight deposit. Clots normally with rennet. Alkaline.

Specific gravity.—1034.

Cream.—2·5 vols per cent.

Lactose.—6·145 g. per cent.

Ash.—0·70 g. per cent.

Total solids.—11·55 g. per cent.

Milk from the *right anterior*, *right posterior*, and *left anterior* quarters mixed together.

Very slightly acid. Slight deposit. Colour normal. Clots normally with rennet.

Specific gravity.—1034.

Cream.—4·5 vols per cent.

Lactose.—6·145 g. per cent.

Ash.—0·70 g. per cent.

Total solids.—11·15 g. per cent.

On December 12th the cow gave 3,510 cc. of milk.
,, 19th ,, ,, 2,480 cc. ,,
,, 26th ,, ,, 1,820 cc. ,,
On January 2nd ,, ,, 1,870 cc. ,,
,, 14th ,, ,, 1,620 cc. ,,
,, 21st ,, ,, 2,500 cc. ,,

The quantity obtained from the various quarters was as follows:—

Date.	Right Anterior Quarter.	Right Posterior.	Left Anterior.	Left Posterior.
December 16	310 cc.	870 cc.	180 cc.	70 cc.
„ 17	780 cc.	890 cc.	280 cc.	84 cc.
„ 18	340 cc.	750 cc.	300 cc.	63 cc.
„ 19	600 cc.	1,150 cc.	400 cc.	80 cc.
„ 20	200 cc.	1,045 cc.	310 cc.	120 cc.
„ 21	600 cc.	1,300 cc.	420 cc.	105 cc.

The milk from the left posterior quarter became serous, with a deposit of clotted casein. The milk from this quarter also diminished, and physical examination of the udder showed the mass in that quarter to be less hard and smaller. The milk from the other quarters increased, and the animal put on flesh during the time it was under observation, viz., 50 days.

Temperature of Cow.

1892.		F.
December 13	9 a.m.	101·2°.
	1 p.m.	100·2°.
	5 p.m.	100·4°.
	9 p.m.	101°.
December 14	9 a.m.	100°.
	1 p.m.	101·1°.
	5 p.m.	100°.
	9 p.m.	100·3°.
December 15	9 a.m.	100·2°.
	1 p.m.	100·4°.
	5 p.m.	100·3°.
	9 p.m.	101·1°.
December 16	9 a.m.	100·1°.
	1 p.m.	100°.
	5 p.m.	101°.
	9 p.m.	100·4°.
December 17	9 a.m.	100·4°.
	1 p.m.	101°.
	5 p.m.	100·2°.
	9 p.m.	101·1°.
December 18	9 a.m.	101·3°.
	1 p.m.	100·1°.
	5 p.m.	100°.
	9 p.m.	101·2°.
December 19	9 a.m.	101°.
	1 p.m.	100·5°.

COW 27.

No tuberculosis; sub-diaphragmatic abscess.

Arrived at Harrow January 17th, 1893.

The cow was about seven years old, and was purchased by a dairyman, who sold her to the Commission. Whilst the property of the dairyman she calved twice, once in October, 1891 (twins), and once in September, 1892, shortly before arrival at Harrow. She had been ailing for the last six months.

The animal was finely developed and had an occasional cough, but no diarrhœa.

Udder.—The two anterior quarters of the udder were enlarged and tender, the right posterior quarter was enlarged but not tender, and the left posterior quarter was normal. Numerous cover-slip preparations were made of the milk from the different quarters; all showed pus cells and cocci from the enlarged quarters, and some very doubtful tubercle bacilli. The milk was in all cases centrifugalized.

The cow was under observation for 41 days.

Milk Analysis, January 18th, 1893.

Milk from *right posterior quarter:*

Unlike milk, settles into two layers, a slimy deposit and a turbid upper layer. Slightly alkaline. Becomes slimy on boiling with Fehling's solution.

Cream.—None.

Lactose.—Trace. 10 cc. of Fehling's solution not decomposed by 8·5 cc. of milk.

Ash.—0·75 g. per cent.

Total solids.—8·2 g. per cent.

Milk from *right anterior quarter:*

Thick, yellow, like pus. Neutral reaction. Becomes slimy on boiling with Fehling's solution.

Specific gravity.—1027.

Cream.—None.

Lactose.—Trace. 10 cc. of Fehling's solution not decomposed by 9·3 cc. of milk.

Ash.—0·75 g. per cent.

Total solids.—10·4 g. per cent.

Milk from the *left anterior quarter:*

A thick yellow liquid like pus. Slightly alkaline.

Cream.—None.

Lactose.—0·87 g. per cent.

Ash.—0·70 g. per cent.

Total solids.—8·0 g. per cent.

Milk from the *left posterior quarter:*

Like normal milk. Slightly alkaline. Clots normally with rennet.

Specific gravity.—1033.

Cream.—9 vols per cent. at 16·5° C.

Lactose.—4·83 g. per cent.

Ash.—0·60 g. per cent.

Total solids.—16·25 g. per cent.

On January 18th the cow gave 3,515 cc. of milk.
„ 25th „ „ 3,120 cc. „
On February 1st „ „ 2,254 cc. „
„ 16th „ „ 2,800 cc. „
„ 23rd „ „ 2,450 cc. „

The quantity of milk obtained from the various quarters was as follows:—

Date.	Right Anterior.	Left Anterior.	Right Posterior.	Left Posterior.
January 18 -	65 cc.	36 cc.	30 cc.	3,400 cc.
„ 19 -	60 cc.	32 cc	38 cc.	4,000 cc.
„ 20 -	42 cc.	38 cc.	30 cc.	3,800 cc.

Temperature of Cow.

1893.		F.
January 17	5 p.m.	101·8°.
	9 p.m.	101·2°.
January 18	9 a.m.	102°.
	1 p.m.	103·8°.
	5 p.m.	102·2°.
	9 p.m.	100·8°.
January 19	9 a.m.	100·8°.
	1 p.m.	101·4°.
	5 p.m.	101°.
	9 p.m.	101·8°.
January 20	9 a.m.	101·4°.
	1 p.m.	100·8°.
	5 p.m.	101°.
	9 p.m.	100·8°.
January 21	9 a.m.	101·2°.
	1 p.m.	101·6°.
	5 p.m.	101·8°.
January 22	9 a.m.	101°.
	1 p.m.	102°.
	5 p.m.	101·2°.
January 23	9 a.m.	101·6°.
	1 p.m.	100·8°
	5 p.m.	101·4°
	9 p.m.	101·2°.
January 24	9 a.m.	101·6°.
	1 p.m.	100·4°.

INQUIRY II.

PART VII.

DETAILS OF THE EXPERIMENTS WITH THE MEAT, VIZ., INOCULATION EXPERIMENTS IN GUINEA-PIGS AND RABBITS; FEEDING EXPERIMENTS IN GUINEA-PIGS, RABBITS, AND PIGS.

The headings of the columns are explanatory of the data given. The microscopical diagnosis of the lesions (tuberculous and non-tuberculous) will be found at the end of the *post-mortem* record of each animal.

The microscopical examination was made with the view of discovering whether the lesion was tuberculous or not. The lesions found were divisible into two chief classes: (1) tuberculous, and (2) those due to other bacteria. The latter are classed as bacterial necrosis.

The abbreviations used are :—

T.B. = tubercle bacilli.
T.B. x = small number of tubercle bacilli.
T.B. xx = large number of tubercle bacilli.
T.B. xxx = very large number of tubercle bacilli.

These experiments are summarised in Tables XVI., XVII., and XVIII., Part II. of the Report. All the experiments performed with the meat and meat-juice are recorded in the following pages. Where meat-juice was used it is specially mentioned.

The inoculations with the meat were made subcutaneously in both groins; with the meat-juice in one or both groins.

At the beginning of the record of those animals that developed the tuberculosis, the word **tuberculosis** is printed in thick type.

EXPERIMENTS WITH THE MEAT OF EIGHT COWS THE SUBJECT OF MILD TUBERCULOSIS.

Cows 1—8.

COW 1.

INOCULATION EXPERIMENTS.

Date of Experiment.	Number of Animals.	Meat used.	Killed in or Died in.	Post-mortem Examination.
Sept. 8, 1892 -	2 guinea-pigs -	**Intercostals** (untrimmed).	A. died in **72 days** B. died in **76 days**	A. } B. } Both animals died of broncho-pneumonia. There was nothing abnormal to be seen at any of the seats of inoculation, and none of the organs or lymph-glands were affected with tubercle or other disease.

FEEDING EXPERIMENTS.

Date of Experiment.	Number of Animals.	Amount Eaten.	Meat used.	Duration of Feeding.	Killed in or Died in.	Post-mortem Examination.
Sept. 8, 1892 -	4 guinea-pigs.	1,000 grams -	**Rump** (untrimmed).	10 days -	A. died in **19 days**	A.—The liver showed numerous yellowish areas. All other organs, the lymph glands, and intestines were normal. *Microscopical Examination.*—Liver, 10 sections; advanced bacterial necrosis due to cocci; no tubercle bacilli. Not tubercular.
					B. died in **20 days** C. died in **40 days** D. died in **75 days**	B. } C. } D. } The cause of death in all these animals was broncho-pneumonia. None of the organs, lymph glands, or intestines in any of these animals were affected with tubercle or other disease.
Sept. 8, 1892 -	1 rabbit -	500 grams -	**Intercostals** (untrimmed).	5 days -	Killed in **95 days** -	There was no tubercle or other disease in any of the organs, lymph glands, or intestines.

COW 2.

INOCULATION EXPERIMENTS.

Date of Experiment.	Number of Animals.	Meat used.	Killed in or Died in.	Post-mortem Examination.
Aug. 14, 1892 -	2 guinea-pigs -	**Rump** (trimmed).	A. died in **55 days** B. killed in **59 days**	A.—Nil at seats of inoculation. Broncho-pneumonia. All other organs and all lymph glands quite normal. No tubercle. B.—Nil at seats of inoculation. All organs and lymph glands were quite normal. No tubercle.
Aug. 14, 1892 -	2 guinea-pigs -	**Rump** (untrimmed).	A. } B. } Killed in **59 days.**	A. } B. } All organs and lymph glands normal. Nil at seats of inoculation. No tubercle anywhere.
Aug. 14, 1892 -	1 rabbit - -	Meat juice from **Rump** (trimmed). 3 cc. each groin.	Killed in **59 days** -	No local lesion. All organs quite normal except the liver, which showed a white nodule on its surface about 1·5 mm. in diameter. All lymph glands were normal. *Microscopical Examination.—Liver*, 9 sections. Slight fibrosis. No caseation. No tubercle bacilli. Not tubercular.
Aug. 13, 1892 -	1 rabbit - -	Meat juice from **Rump** (untrimmed). 5 cc. each groin.	Died in **29 days** -	There was nothing to be seen at either seat of inoculation. There was no tubercle in any organ or lymph gland.

FEEDING EXPERIMENTS.

Date of Experiment.	Number of Animals.	Amount eaten.	Meat used.	Duration of Feeding.	Killed in or Died in.	Post-mortem Examination.
Aug. 13, 1892	4 guinea-pigs.	580 grams -	**Rump** (trimmed).	6 days -	A. died in **36 days** B. died in **53 days** C. died in **83 days** D. died in **105 days**	A.—Broncho-pneumonia. There was no tubercle in any of the lymph glands, organs, or intestines. B.—The spleen showed a few white nodules. All other organs, lymph glands, and intestines were normal. *Microscopical Examination.—Spleen*, 8 sections; bacterial necrosis due to bacilli. No tubercle bacilli. Not tubercular. C. D. Broncho-pneumonia. There was no tubercle in any of the organs, lymph glands, or intestines.
Aug. 15, 1892	1 rabbit -	475 grams -	**Rump** (trimmed).	4 days -	Killed in **119 days**	There was no tubercle in any of the organs, lymph glands, or intestines.
Aug. 13, 1892	4 guinea-pigs.	600 grams -	**Rump** (untrimmed).	6 days -	A. died in **53 days** B. died in **88 days** C. died in **97 days** D. died in **109 days**	A. B. C. D. The cause of death in all four animals was broncho-pneumonia. There was no tubercular lesion in any of the organs, lymph glands, or intestines.
Aug. 15, 1892	1 rabbit -	500 grams -	**Rump** (untrimmed).	4 days -	Killed in **122 days**	There was no tubercle in any of the organs, lymph glands, or intestines.
Aug. 14, 1892	2 guinea-pigs.	250 cc. - -	Meat juice from **Rump** (untrimmed).	4 days -	A. died in **61 days** B. died in **67 days**	A. B. Broncho-pneumonia. There was no tubercle in any of the organs, lymph glands, or intestines.

COW 3.

INOCULATION EXPERIMENT.

Date of Experiment.	Number of Animals.	Meat used.	Killed in or Died in.	Post-mortem Examination.
Nov. 18, 1891 -	1 guinea-pig - -	**Rump and Loin** (trimmed).	Died in **52 days** -	No scars visible at seats of inoculation, and no signs of the pieces of meat introduced. All glands and organs normal. No tubercle anywhere.

FEEDING EXPERIMENTS.

Date of Experiment.	Number of Animals.	Amount Eaten.	Meat used.	Duration of Feeding.	Killed in or Died in.	Post-mortem Examination.
Nov. 18, 1801	4 guinea-pigs.	650 grams -	**Rump and Loin** (trimmed).	11 days -	A. died in **3 days** - B. died in **4 days** - C. died in **53 days** D. died in **56 days**	A. B. C. None of the organs, lymph glands, or intestines were affected with tubercle or other evident disease. D. Lungs congested. *Liver* showed a few minute scattered white spots. All other organs and lymph glands normal. Intestines normal. *Microscopical Examination.—Liver*, 12 sections; showed some degeneration of the liver cells in parts. No caseation. No tubercle bacilli.

COW 4.

INOCULATION EXPERIMENTS.

Date of Experiment.	Number of Animals.	Meat used.	Killed in or Died in.	Post-mortem Examination.
June 2, 1891 -	1 guinea-pig -	**Rump.** (trimmed).	Killed in **94 days** -	No scar or swelling at seats of inoculation. *Heart, lungs, liver, kidneys*, and *suprarenals* normal. *Spleen* pale, otherwise normal. *Stomach, small* and *large gut*, normal. All lymph glands normal.
June 2, 1891 -	1 guinea-pig -	**Breast.** (trimmed).	Killed in **157 days**	No scar or swelling at seats of inoculation. Very fat and well nourished. All glands and all organs perfectly normal.

FEEDING EXPERIMENTS.

Date of Experiment.	Number of Animals.	Amount Eaten.	Meat used.	Duration of Feeding.	Killed in or Died in.	Post-mortem Examination.
June 3, 1891 -	4 guinea-pigs.	1,000 grams -	**Rump** - (trimmed).	4 days -	A. killed in **80 days** B. C. D. killed in **158 days.**	A.—Very fat. No tubercle in intestines or any organs. There was a white patch on the surface of liver. *Microscopical Examination.—Liver,* 13 sections. Fatty liver. An attendant placed four non-experimental animals in this cage. All the animals were killed two days later. Four of the animals were quite healthy. Of those not healthy:— *Guinea-pig* 1.—Liver showed a small white granular patch $\frac{1}{8}$ to $\frac{1}{4}$ inch in diameter on its anterior margin. Otherwise all organs and glands normal. Intestines normal. *Guinea-pig* 2.—Spleen showed a hard, white, rounded nodule, $\frac{1}{8}$ inch in diameter, and raised above the surface. In the rectum projecting from the mucous membrane was a hard opaque nodule $\frac{1}{8}$ inch in diameter. All other tissues normal. *Microscopical Examination.—Spleen,* 3 sections. Nodules of degenerating round cells. No tubercle bacilli. Not tubercular. *Rectum.*—An amorphous mass in a hypertrophied solitary gland. Not tubercular. No tubercle bacilli. *Guinea-pig* 3.—On the upper surface of the liver were a few minute white opaque spots, which were quite superficial. All other organs and glands were normal. Intestines normal.
June 3, 1891	4 guinea-pigs	800 grams -	**Loin** - - (trimmed).	3 days -	A. killed in **80 days**	A.—Very fat. All organs and glands normal, except *lungs*, which showed on the surface several small translucent bodies the size of a pin's head, surrounded by a zone of congestion. *Microscopical Examination.—Lung,* 12 sections. Showed a proliferation of the alveolar epethelium. No caseation. No tubercle bacilli. Not tubercular.
					B. died in **90 days**	B.—*Lungs, kidneys, suprarenals,* and all *lymph glands* normal. Near one Peyer's patch in the upper part of the jejunum was a small hard white nodule in the mucous membrane, the size of a pin's head. *Liver* showed on its surface five white nodules, soft and caseous, 2 to 4 mm. in diameter. On the right edge next to the diaphragm was a recent deposit of lymph over a wedge-shaped yellowish area in the liver substance (like an infarct). This area measured about $\frac{3}{4}$ by $\frac{1}{2}$ inch. One of the nodules was examined for tubercle bacilli. None were found in two cover-glass preparations. *Spleen* enlarged. Showed eight projecting white nodules on its surface, of 1 to 5 mm. in diameter, and several smaller ones in its substance. Two cover-slip preparations made of spleen nodule. No tubercle bacilli. *Microscopical Examination—Small gut,* 46 sections. Nothing abnormal. *Liver,* 13 sections. Areas of necrosis. No tubercle bacilli. Other bacilli blocking vessels. Bacterial necrosis. Not tubercular. *Spleen,* 20 sections. Necrosis of cells in parts, due to bacilli. No tubercle bacilli. No caseation. Bacterial necrosis.
					C. and D. killed in **179 days.**	C. and D.—All organs, lymph glands, and intestines were quite normal.
June 3, 1891	2 guinea pigs.	200 grams -	**Breast** - (trimmed).	1 day -	A. killed in **85 days** B. killed in **158 days.**	A.—All organs, lymph glands, and intestines were quite normal. B.—Very fat. All organs, lymph glands, and intestines were quite normal A pregnant doe had been placed in this cage accidentally by the attendant. This animal was killed two days afterwards, and found to be quite healthy in every respect.

COW 5.

INOCULATION EXPERIMENT.

Date of Experiment.	Number of Animals.	Meat used.	Killed in or Died in.	Post-mortem Examination.
Nov. 18, 1891 -	1 guinea-pig - -	**Rump and Loin** (trimmed).	Died in **46 days** -	No sign of pieces of meat on either side. All lymph glands normal. Lungs congested. All other organs normal. No tubercle.

FEEDING EXPERIMENTS.

Date of Experiment.	Number of Animals.	Amount Eaten.	Meat used.	Duration of Feeding.	Killed in or Died in.	Post-mortem Examination.
Nov. 18, 1891	4 guinea-pigs.	950 grams -	**Rump and Loin** (trimmed).	11 days -	A. died in **36 days** B. died in **44 days** C. killed in **81 days** D. killed in **81 days**	A.—All organs, glands, and intestines normal. No tubercle. B.—A small hæmorrhage into one of the mesenteric glands. All organs, intestines, and lymph glands normal. No tubercle. C.—All organs, glands, and intestines normal. No tubercle. D.—All organs, glands, and intestines normal. No tubercle.

COW 6.

INOCULATION EXPERIMENTS.

Date of Experiment.	Number of Animals.	Meat used.	Killed in or Died in.	Post-mortem Examination.
Mar. 27, 1892 -	1 guinea-pig - -	Juice from **Rump** (trimmed). 0·6 cc. right groin.	Died in **56 days** -	Nothing at seat of inoculation, except some slight thickening. No glands in the neighbourhood or elsewhere affected. Lungs showed broncho-pneumonia. Other organs normal. No tubercle.
Mar. 27, 1892 -	1 guinea-pig - -	Juice from **Rump** (untrimmed). 0·6 cc. right groin.	Died in **35 days** -	There was nothing at the seat of inoculation, but one of the inguinal glands was enlarged and hardened. No other lymph glands were abnormal. Lungs showed lobular pneumonia. All other organs normal. *Microscopical Examination.—Inguinal* gland, 15 sections. An inflammatory hyperplasia of lymphoid tissue with one or two minute areas of cell necrosis. No caseation. No tubercle bacilli. Not tubercular.
Mar. 27, 1892 -	1 rabbit - -	Juice from **Rump** (untrimmed). 1 cc. each groin.	Killed in **120 days**	**Tuberculosis.** There were some enlarged glands on the left side at the seat of inoculation, which were caseous on section. Nothing at the seat of inoculation on the right side. No other lymph glands affected. The liver contained a white nodule, and the *lungs* contained several. No other organs affected. *Microscopical Examination.*—Gland on left side, 15 sections. Caseous tubercle. T.B. x.

FEEDING EXPERIMENTS.

Date of Experiment.	Number of Animals.	Amount Eaten.	Meat used.	Duration of Feeding.	Killed in or Died in.	Post-mortem Examination.
Mar. 26, 1892	4 guinea-pigs.	1,400 grams -	**Rump** (trimmed).	14 days -	A. died in **16 days**	A.—Lungs showed extensive pneumonic consolidation. All other organs, all lymph glands, and the intestines were quite normal to the naked eye. No tubercle.
					B. died in **24 days**	B.—Pneumonia. Other organs and all glands healthy. The duodenum showed a small ulcer, non-tubercular. The rest of the intestines were quite normal. No tubercle.
					C. died in **36 days** D. died in **36 days**	C. D. } Pneumonia. All lymph glands and other organs normal. Intestines normal. No tubercle.
Mar. 26, 1892	4 guinea-pigs.	1,385 grams -	**Rump** (untrimmed).	14 days -	A. died in **24 days**	A.—Broncho-pneumonia. In the duodenum about half an inch below the pylorus was a small inflamed patch just commencing to ulcerate in the centre. Non-tubercular. All lymph glands normal. The remaining organs and intestines were quite normal. No tubercle.
					B. died in **29 days**	B.—Lungs pneumonic. No tubercle in any of the organs, lymph glands, or intestines.
					C. died in **32 days** D. died in **41 days**	C. D. } Pneumonia. There was no tubercle in any of the organs, lymph glands, or intestines.
Mar. 27, 1892	1 pig -	5,700 grams -	**Rump** (trimmed).	6 days -	Killed in **110 days**	The animal was very fat and well nourished. *Serous membranes* were normal. *Organs.*—The *heart, lungs, liver, spleen, kidneys, suprarenals,* and *ovaries* were quite normal. *Lymph glands.—Pelvic, lumbar colic, cœliac mesenteric, anterior* and *posterior mediastinal, bronchial,* and *cervical* glands were all quite normal. *Tonsils* and *larynx* normal. *Intestines.—Large,* quite normal. *Small,* quite normal. There was no tubercle anywhere.

COW 7.

INOCULATION EXPERIMENTS

Date of Experiment.	Number of Animals.	Meat used.	Killed in or Died in.	Post-mortem Examination.
Nov. 25, 1892 -	2 guinea-pigs -	**Rump** (untrimmed).	A. died in **1 day** - B. died in **9 days** -	A.—The seats of inoculation contained the meat unabsorbed. There was no tubercle in any organ or lymph gland. B.—There was a large abscess at the seat of inoculation on either side. All lymph glands and organs were normal. *Microscopical Examination.—Abscess wall,* 10 sections. A small-celled infiltration of the connective tissue and round the muscle-fibres. No caseation. No tubercle bacilli. Not tubercular.
Nov. 29 1892 -	2 guinea-pigs -	**Rump** (untrimmed).	A. died in **24 hours** B. died in **24 hours**	A. B. } The cause of death in both animals was acute peritonitis. There was no tubercle in any organ or lymph gland.
Nov. 26, 1892 -	2 guinea-pigs -	Meat-juice from **Rump** (untrimmed). 1 cc. each groin.	A. died in **2 days** - B. died in **2 days** -	A.—Died of pneumonia. There was no tubercle in any organ or lymph gland. B.—Died of acute septicæmia. There was no tubercle in any organ or lymph gland.

Feeding Experiments.

Date of Experiment.	Number of Animals.	Amount Eaten.	Meat used.	Duration of Feeding.	Killed in or Died in.	Post-mortem Examination.
Nov. 23, 1892	4 guinea-pigs.	800 grams -	**Rump** (untrimmed).	8 days -	A. died in **11 days** - B. died in **13 days** - C. died in **28 days** - D. died in **31 days** -	A, B, C, D. None of the organs, glands, or intestines of these animals were affected with tubercle. The cause of death in every case was broncho-pneumonia.
Nov. 23, 1892	4 guinea-pigs.	800 grams -	**Rump** (untrimmed).	8 days -	A. died in **12 days** - B. died in **13 days** - C. died in **14 days** - D. died in **33 days** -	A, B, C, D. The cause of death in all these animals was pneumonia. There was no tubercle in any of the organs, lymph glands, or intestines.

COW 8,

Inoculation Experiments.

Date of Experiment.	Number of Animals.	Meat used.	Killed in or Died in.	Post-mortem Examination.
Nov. 27, 1892 -	2 guinea-pigs -	**Rump** (untrimmed).	A. died in **6 days** -	A.—There was a small caseous gland at the seat of inoculation on the right side. No other lymph glands were affected. The lungs showed double pneumonia, but there was no tubercle in any organ. *Microscopical Examination.*—Local lesion, 8 sections. An inflammatory tissue necrosis due to cocci in groups. No tubercle bacilli. Not tubercular. Bacterial necrosis.
			B. died in **26 days** -	B.—The cause of death was broncho-pneumonia. There was no tubercle in any gland or organ.
Nov. 27, 1892 -	2 guinea-pigs -	Meat-juice from **Rump** (untrimmed).	A. died in **10 days** - B. died in **12 days** -	A., B. Both animals died of pneumonia. There was nothing abnormal at the seats of inoculation. There was no tubercle in any organ or lymph gland.

Feeding Experiments.

Date of Experiment.	Number of Animals.	Amount Eaten.	Meat used.	Duration of Feeding.	Killed in or Died in.	Post-mortem Examination.
Nov. 23, 1892	4 guinea-pigs.	800 grams -	**Rump** (untrimmed).	8 days -	A. died in **11 days** - B. died in **11 days** -	A., B. Both animals died of broncho-pneumonia. There was no tubercle in any of the organs, lymph glands, or intestines.
					C. died in **16 days** -	C.—The liver and spleen showed numerous small whitish nodules. All other organs and the lymph glands, and intestines were quite normal. *Microscopical Examination.—Liver*, 9 sections. Bacterial necrosis due to bacilli. No tubercle bacilli. Not tubercular. *Spleen*, 12 sections. Cell necrosis. No tubercle bacilli. Not tubercular.
					D. died in **32 days** -	D.—Broncho-pneumonia. There was no tubercle in any of the organs, lymph glands, or intestines.
Nov. 23, 1892	4 guinea-pigs	800 grams -	**Rump** (untrimmed).	8 days -	A. died in **10 days** - B. died in **13 days** - C. died in **13 days** - D. died in **33 days** -	A, B, C, D. The cause of death in all these animals was broncho-pneumonia. There was no tubercle in any of the organs, lymph-glands, or intestines.

EXPERIMENTS WITH THE MEAT OF EIGHT COWS THE SUBJECT OF MODERATE TUBERCULOSIS.

Cows 9—16.

COW 9.

INOCULATION EXPERIMENT.

Date of Experiment.	Number of Animals.	Meat used.	Killed in or Died in.	Post-mortem Examination.
June 24, 1891	1 guinea-pig	**Rump** (trimmed).	Killed in **62 days**	**Tuberculosis.** *Right side.*—Nil. *Left side.*—Inside the nipple at the seat of inoculation was a small hard nodule with a scab over it. Beneath the parietal peritoneum opposite the spleen was an abscess about ¼ inch in diameter containing cheesy pus. This pus showed a few tubercle bacilli on microscopical examination. The *spleen* was enlarged, and showed projecting from its surface numerous whitish nodules, which were wedge-shaped on section. The *liver* showed a few white small nodulos at its anterior edge. All other organs, lymph glands, and intestines were normal. *Microscopical Examination.*—*Scar*, 24 sections; showed a healing ulcer with chronic inflammatory connective tissue around. Round cells, giant cells, and T.B. x. *Spleen*, 29 sections. No caseation. Bacterial necrosis. No tubercular structure. No tubercle bacilli.

FEEDING EXPERIMENTS.

Date of Experiment.	Number of Animals.	Amount Eaten.	Meat used.	Duration of Feeding.	Killed in or Died in.	Post-mortem Examination.
June 23, 1891	2 guinea-pigs.	450 grams	**Rump** (with visible tubercle).	2 days	A. was killed in **62 days.**	A.—Fat. Liver showed in one lobe a whitish-yellow superficial area about ⅓ inch across, and in another lobe a somewhat smaller area of similar character. All other organs, lymph glands, and intestines normal. *Microscopical Examination.*—Liver, 10 sections. Showed a slight, small, round-celled infiltration at one spot. No tubercular structure. No caseation. No tubercle bacilli.
					B. killed in **162 days.**	B.—Very fat. All organs and lymph glands normal. The *ileum* showed two greatly enlarged and infiltrated Peyer's patches. Nil otherwise in intestines. *Microscopical Examination.*—63 sections of the Peyer's patches were examined and showed a hyperplasia of lymphoid tissue. There was no cell-necrosis, no tubercular structure, and no tubercle bacilli.
June 23, 1891	4 guinea-pigs.	724 grams	**Rump** (without visible tubercle).	2 days	A. killed in **62 days**	A.—Fat. *Spleen* and *liver* contained nodules with soft whitish contents the size of a split pea. All other organs, glands, and intestines were normal. Cover-glass preparations of spleen nodule showed no tubercle bacilli. *Microscopical Examination.*—*Liver*, 16 sections. A collection of small round cells. Not tubercular. No tubercle bacilli. *Spleen*, 16 sections. Showed the same microscopical appearances as the liver. Not tubercular. No tubercle bacilli.
					B., C., and D. killed in **162 days.**	B., C., and D. were all fat and well nourished. All organs, glands, and intestines were quite normal.
June 23, 1891	2 guinea-pigs.	230 grams	**Intercostals** and **Diaphragm** (trimmed).	2 days	A. killed in **62 days**	A.—Very fat. All lymph glands, intestines, and organs normal, except *liver*, which showed two small yellowish nodules the size of half a split pea. *Microscopical Examination.*—*Liver*, 10 sections. No tubercle.
					B. killed in **162 days.**	B.—Fat and well nourished. There was white nodule in the anterior border of the liver, about ⅓ inch in diameter, hard and surrounded by connective tissue. On section showed soft yellow matter in the centre. All other organs, lymph glands, and intestines normal.

COW 10.

INOCULATION EXPERIMENTS.

Date of Experiment.	Number of Animals.	Meat used.	Killed in or Died in.	Post-mortem Examination.
April 7, 1892	1 guinea-pig	**Rump** (untrimmed meat-juice). 1 cc. each groin.	Died in **44 days**	Nothing abnormal to be seen at either seat of inoculation. The lymph glands in the neighbourhood and elsewhere were quite normal. None of the organs were affected with tubercle or other evident disease.
April 21, 1892	1 guinea-pig	**Rump** (trimmed meat-juice). 1 cc. each groin.	Died in **32 hours**	Very little of the fluid injected had been absorbed. The muscles were sodden, the spleen and kidneys were engorged, both ventricles of the heart were full of dark venous blood, and the whole appearance of the animal was that of acute septic poisoning. (The meat-juice injected was 16 days old.)

Feeding Experiments

Date of Experiment.	Number of Animals.	Amount Eaten.	Meat used.	Duration of Feeding.	Killed in or Died in.	Post-mortem Examination.
April 7, 1892	4 guinea-pigs.	1,400 grams	**Rump** (trimmed)	14 days -	A. died in **16 days** B. died in **25 days** C. died in **25 days** D. died in **44 days**	A.—Acute peritonitis, probably traumatic in origin. No tubercle in any of the organs, lymph glands, or intestines. B.—In the first part of the *duodenum* was an ulcer which communicated with a small sloughing cavity in the under surface of the liver. The portal vein was thrombosed. All the other organs were normal. All lymph glands and the rest of the intestines were normal. No tubercle. C.—The *liver* on section showed its right lobe to be full of a greenish-yellow cheese-like substance, six cover-slip preparations of which showed no tubercle bacilli. Portal vein thrombosed. All other organs, all lymph glands, and the intestines, were normal. There was no tubercle anywhere. D.—*Lungs* showed pneumonia. No tubercle in any of the organs, lymph glands, or intestines.
April 7, 1892	1 guinea-pig.	62 cc. - -	**Rump** (untrimmed meat-juice).	1 day -	Died in **40 days**	The lungs were slightly affected with broncho-pneumonia. There was no tubercle in any of the lymph glands, organs, or intestines.

COW 11.

Inoculation Experiments.

Date of Experiment.	Number of Animals.	Meat used.	Killed in or Died in.	Post-mortem Examination.
Sept. 9, 1892 -	1 guinea-pig -	**Intercostals** (untrimmed).	Died in **45 days**	Nil at either seat of inoculation. None of the organs or lymph glands were affected with tubercle.
Sept. 9 1892 -	1 guinea-pig -	**Rump** (untrimmed).	Died in **53 days**	Nil at either seat of inoculation. None of the organs or lymph glands were affected with tubercle.

Feeding Experiments.

Date of Experiment.	Number of Animals.	Amount Eaten.	Meat used.	Duration of Feeding.	Killed in or Died in.	Post-mortem Examination.
Sept. 9, 1892	4 guinea-pigs.	900 grams -	**Rump** (untrimmed).	9 days -	A. died in **50 days** B. died in **94 days** C. died in **95 days** D. died in **101 days**	A.—One of the glands round the stomach was enlarged and showed numerous small white points on section. There was no tubercle in any of the glands, organs, or intestines. *Microscopical Examination.—Gland near stomach,* nine sections. Bacterial necrosis of gland tissue due to bacilli. No tubercle bacilli. Not tubercular. B. C. D. } The cause of death in all these animals was broncho-pnemonia. None of the organs, lymph glands, or intestines were affected with tubercle.
Sept. 9, 1892	1 rabbit	570 grams -	**Intercostals** (untrimmed).	6 days -	Killed in **92 days**	All organs, lymph glands, and intestines were quite normal. No tubercle.

COW 12.

Inoculation Experiments.

Date of Experiment.	Number of Animals.	Meat used.	Killed in or Died in.	Post-mortem Examination.
Oct. 23, 1892 -	1 guinea-pig -	**Rump** (untrimmed).	Died in **29 days**	Nothing abnormal to be seen at seats of inoculation. No tubercle in any of the organs or lymph glands.
Oct. 23, 1892 -	1 guinea-pig -	Meat-juice from **Rump** (untrimmed). 1 cc. each groin.	Died in **10 days**	There was no tubercle at the seats of inoculation, or in any of the organs or lymph glands.

Feeding Experiments.

Date of Experiment.	Number of Animals.	Amount Eaten.	Meat used.	Duration of Feeding.	Killed in or Died in.	Post-mortem Examination.
Oct. 21, 1892	4 guinea-pigs.	1,160 grams -	**Rump** (untrimmed).	12 days -	A. died in **23 days** B. died in **36 days** C. died in **37 days** D. died in **39 days**	A. B. C. The cause of death in all these animals was pneumonia. None of the organs, lymph glands, or intestines were affected with tubercle. D.—The *spleen* showed some small whitish nodules. All the other organs, all the lymph glands, and the intestines were quite normal. *Microscopical Examination.*—Spleen, 31 sections. Necrotic areas. Bacterial necrosis. No tubercle bacilli. Not tubercular.
Oct. 21, 1892	1 rabbit	960 grams -	**Rump** (untrimmed).	10 days -	Killed in **88 days**	There was no tubercle in any of the organs, lymph glands, or intestines.
Oct. 23, 1892	1 pig	6,110 grams -	**Rump** (untrimmed).	7 days -	Killed in **98 days**	*Serous membranes.*—All normal. *Organs.*—*Heart, lungs, liver, spleen, thyroid, kidneys, suprarenals, ovaries,* and *uterus,* were normal. *Tongue, tonsils,* and *larynx* were normal. *Lymph glands.*—The mesenteric, cœliac, lumbar, anterior and posterior mediastinal and bronchial glands, and the glands in the lesser omentum were normal. *Salivary glands.*—The right sub-maxillary was harder than normal, and showed on section a small, soft, yellow point about 4 mm. in diameter. *Intestines.*—Both large and small were normal. *Microscopical Examination.*—Salivary gland, nine sections. Not tubercular.

COW 13.

Inoculation Experiments.

Date of Experiment.	Number of Animals.	Meat used.	Killed in or Died in.	Post-mortem Examination.
Nov. 13, 1892 -	1 rabbit - -	**Rump** (untrimmed).	Killed in **85 days** -	**Tuberculosis.** Nil at seat of inoculation on left side. At the seat of inoculation on the right side was a caseous abscess with ragged walls surrounded by some enlarged and caseous glands. The *lumbar gland* on the right side was enlarged and caseous, as were also the *cœliac, mediastinal,* and *bronchial* glands. The *liver, spleen,* and *lungs* showed nodules of tubercle, and there were numerous nodules on the pleural surface of the diaphragm. Other organs and glands normal. *Microscopical Examination.*— Five cover-slip preparations were made of the caseous matter from the abscess, showed numerous tubercle bacilli and pus cells, but no streptococci. Two cover-slip preparations were made of the caseous lumbar gland; showed numerous tubercle bacilli in groups as well as singly.
Nov. 13, 1892 -	1 rabbit - -	Meat-juice from **Rump** (untrimmed). 1 cc. each groin.	Killed in **66 days** -	**Tuberculosis.** In the muscles on the inner side of the right thigh was a small caseous mass. All lymph glands were normal, and all organs were normal. There was nothing to be seen at the seat of inoculation on the left side. *Microscopical Examination.*—*Caseous mass in right thigh,* eight sections; showed muscle-fibres with small and large celled infiltration, cell degeneration; T.B. xx.

Feeding Experiments.

Date of Experiment.	Number of Animals.	Amount Eaten.	Meat used.	Duration of Feeding.	Killed in or Died in.	Post-mortem Examination.
Nov. 1, 1892	4 guinea-pigs.	600 grams -	**Rump** (untrimmed).	6 days -	A. died in **8 days** - B. died in **16 days** - C. died in **16 days** - D. died in **19 days** -	A. B. C. D. The cause of death in all these animals was broncho-pneumonia. None of the organs, lymph glands, or intestines were affected with tubercle.
Nov. 11, 1892	4 guinea-pigs.	600 grams -	**Rump** (untrimmed).	6 days -	A. died in **8 days** - B. died in **10 days** - C. died in **27 days** - D. died in **28 days**	A. B. C. All these animals died of broncho-pneumonia. None of the organs, lymph glands, or intestines were affected with tubercle. D.—In the first part of the duodenum was a small simple ulcer covered with a greyish slough. There was no tubercle in any of the organs, lymph glands, or intestines.

COW 14.

INOCULATION EXPERIMENT.

Date of Experiment.	Number of Animals.	Meat used.	Killed in or Died in.	Post-mortem Examination.
Nov. 18 1891	1 guinea-pig	**Rump** and **Loin** (trimmed).	Died in **46 days**	Nothing abnormal at seats of inoculation. No signs of the meat. All lymph glands normal. Lungs were congested, but all other organs were normal.

FEEDING EXPERIMENT.

Date of Experiment.	Number of Animals.	Amount Eaten.	Meat used.	Duration of Feeding.	Killed in or Died in.	Post-mortem Examination.
Nov. 18, 1891	4 guinea-pigs.	950 grams	**Rump** and **Loin** (trimmed).	11 days	A. died in **42 days**	A.—All organs, lymph glands, and instestines normal. No tubercle.
					B. died in **54 days**	B.—All organs and intestines normal. One of the mesenteric glands showed a slight ecchymosis in its substance. All other lymph glands normal. No tubercle.
					C. killed in **79 days**	C.—Some of the Peyer's patches were enlarged and inflamed. One mesenteric gland slightly enlarged. All other tissues normal. *Microscopical Examination.* — *Mesenteric gland,* 15 sections. No caseation. No tubercle bacilli. Not tubercular.
					D. killed in **79 days**	D.—Slight inflammation of one or two Peyer's patches. All glands and organs normal. No tubercle.

COW 15.

INOCULATION EXPERIMENTS.

Date of Experiment.	Number of Animals.	Meat used.	Killed in or Died in.	Post-mortem Examination.
July 23, 1892	2 guinea-pigs	**Rump** (trimmed).	A. died in **7 days**	A.—At the seat of inoculation on the right side was a large slough from which an abscess extended upwards between the skin and the muscles of the abdominal wall. No tubercle in any gland or organ.
			B. died in **22 days**	B.—At the seat of inoculation on the right side was a large abscess with thickened walls. No glands or organs affected with tubercle. *Microscopical Examination.—Local lesion,* nine sections; showed inflammatory thickening and necrosis. No tubercle bacilli. Not tubercular.
July 23, 1892	2 guinea-pigs	**Rump** (untrimmed).	A. died in **3 days**	A.—Œdema at the seats of inoculation. Acute septicæmia. No tubercle in any organ or lymph gland.
			B. died in **24 days**	B.—There were two superficial ulcers at the seats of inoculation. Lungs showed pneumonia. No tubercle in any organ or lymph gland. *Microscopical Examination.—Local lesion,* nine sections. Inflammatory thickening. No caseation. No tubercle bacilli. Not tubercular.
July 25, 1892	1 guinea-pig	Meat-juice from **Rump** (trimmed). 1 cc. right groin.	Killed in **79 days**	**Tuberculosis.** There were two *glands* in the *right groin* greatly enlarged and caseous on section. No glands enlarged in the left groin. The right lumbar, the cœliac, the posterior mediastinal, and the bronchial glands, and the glands in the gastro-hepatic omentum were enlarged and caseous. The cervical, cœcal, and mesenteric glands were normal, as were also the anterior mediastinal. The *lungs* showed six small tubercles. The *liver* showed a triangular mass at its edge, whitish at the periphery, soft and purulent-looking in the centre. The *spleen* showed one whitish module projecting from its surface. Heart, kidneys, suprarenals, pancreas, and thymus normal. *Microscopic Examination.—Bronchial gland,* seven sections, showed caseous tubercle. T.B. x.

FEEDING EXPERIMENTS.

Date of Experiment.	Number of Animals.	Amount Eaten.	Meat used.	Duration of Feeding.	Killed in or Died in.	Post-mortem Examination.
July 22, 1892	4 guinea-pigs.	700 grams	**Rump** (trimmed).	7 days	A. died in **7 days**	A.—Pneumonia. No organs, lymph glands, or intestines were affected with tubercle.
					B. died in **20 days**	B.—Pneumonia. All organs and lymph glands normal. The *intestines* showed in some of its Peyer's patches numerous small round white nodules. *Microscopical Examination.—Peyer's patch.* 19 sections. Hyperplasia of the lymphoid tissue, and some necrotic areas near the muscularis mucosæ due to numerous groups of rods. No tubercle bacilli. Not tubercular. Bacterial necrosis (*see* Plate IV.).
					C. died in **25 days**	C.—The *intestines* and *liver* showed the same appearances as in B. All lymph glands and the other organs were normal. The rest of the intestines were normal. No tubercle.
					D. killed in **82 days**	D.—All organs, lymph glands, and intestines were quite normal There was no tubercle anywhere.

Date of Experiment.	Number of Animals.	Amount Eaten.	Meat used.	Duration of Feeding.	Killed in or Died in.	Post-mortem Examination.
July 22, 892	4 guinea-pigs.	500 grams -	**Rump** (untrimmed).	5 days -	A. died in **4 days** -	A.—*Spleen* showed two small, hard, white nodules. The *Peyer's patches* near the ileo-cœcal valve showed similar nodules. The cæcum and the rest of the intestines were normal. All lymph glands and all other organs were normal. *Microscopical Examination.—Small intestine,* 18 sections. No caseation or tubercle bacilli. Not tubercular.
					B. died in **7 days** -	B.—None of the organs, lymph glands, or intestines were affected with tubercle.
					C. died in **40 days** -	C.—The left *lung* showed a yellowish nodule at the apex of the lower lobe. The *liver* and *spleen* showed several small white modules. The intestines, lymph glands, and other organs were normal. *Microscopical Examination. — Lung* 15 sections. Areas of bacterial necrosis. No tubercle bacilli. Not tubercular. *Liver,* 18 sections. Fatty. No tubercle bacilli. *Spleen,* 15 sections. Necrotic areas. No tubercle bacilli.
					D. killed in **81 days**	D.—All organs, lymph glands, and intestines were quite normal. There was no tubercle anywhere.

COW 16.

Inoculation Experiments.

Date of Experiment.	Number of Animals.	Meat used.	Killed in or Died in.	Post-mortem Examination.
June 17, 1892 -	1 guinea-pig -	Meat-juice from **Rump** (trimmed). 1 cc. right groin.	Died in **24 days** -	At the seat of inoculation was a large abscess. There were no lymph glands anywhere enlarged. All organs were normal. *Microscopical Examination.—Seat of inoculation,* 10 sections, Showed an inflammatory necrosis of cells. There was an interstitial small round-celled infiltration of the muscle fibres. No tubercle bacilli. Not tubercular.
June 17, 1892 -	1 rabbit - -	Meat-juice from **Rump** (trimmed). 5 cc. one groin, 3·5 cc. other groin.	Killed in **113 days**	There was nothing abnormal to be seen at the seats of inoculation. All organs and lymph glands were normal. No tubercle.
June 17, 1892 -	1 guinea-pig -	Meat-juice from **Rump** (untrimmed). 2 cc. right groin.	Died in **34 days** -	All organs were normal, with the exception of the lungs, which were affected with broncho-pneumonia. No tubercle.
June 17, 1892 -	1 rabbit - -	Meat-juice from **Rump** (untrimmed). 5 cc. each groin.	Died in **38 days** -	Nothing abnormal to be seen at the seats of inoculation, and no enlargement of any glands. The lungs showed pneumonia. All other organs were normal. There was no tubercle.

Feeding Experiments.

Date of Experiment.	Number of Animals.	Amount Eaten.	Meat used.	Duration of Feeding.	Killed in or Died in.	Post-mortem Examination.
June 15, 1892	4 guinea-pigs.	1,400 grams -	**Rump** (trimmed).	14 days -	A. died in **33 days**	A.—The lungs were extensively affected with broncho-pneumonia. All other organs, the lymph glands, and the intestines were normal. No tubercle.
					B. died in **35 days**	B.—Broncho-pneumonia. There was a perforating ulcer of the *duodenum*; all lymph glands and the remaining organs and intestines were normal. No tubercle.
					C. died in **35 days**	C.—Broncho-pneumonia. There was a small perforating ulcer of the *duodenum*. All lymph glands and the remaining organs and intestines were normal. No tubercle.
					D. died in **35 days**	D.—Broncho-pneumonia. All other organs, the lymph glands, and the intestines were normal. No tubercle.
June 15, 1892	4 guinea-pigs.	1,400 grams -	**Rump** (untrimmed).	14 days -	A. died in **28 days**	The post-mortem examinations of all these animals showed the cause of death in each case to be broncho-pneumonia. No other organs were diseased. All lymph glands and the intestines were healthy. None of the animals were affected with tubercle.
					B. died in **32 days**	
					C. died in **33 days**	
					D. died in **33 days**	

EXPERIMENTS WITH THE MEAT OF FIVE COWS THE SUBJECT OF ADVANCED AND GENERALIZED TUBERCULOSIS.

COWS 19—23.

COW 19.

FEEDING EXPERIMENTS.

Date of Experiment.	Number of Animals.	Amount Eaten.	Meat used.	Duration of Feeding,	Killed in or Died in.	Post-mortem Examination.
June 23, 1891	4 guinea-pigs.	230 grams -	**Rump** (trimmed).	2 days -	A. died in **3 days** - B. died in **3 days** - C. died in **22 days** D. died in **99 days**	A.—No tubercle anywhere. B.—Acute peritonitis. No tubercle anywhere. C.—There were some ecchymoses in some of the Peyer's patches. No trace of tubercle anywhere. D.—All organs perfectly normal. No tubercle anywhere.
June 23, 1891	2 guinea-pigs.	400 grams -	**Intercostals and Diaphragm** (trimmed).	2 days -	A. killed in **64 days** B. killed in **162 days**	A.—Intestines and all lymph glands normal. All organs normal except *liver*, which showed on its surface two or three nodules, less than the size of a split pea. Cover-glass preparations showed no tubercle bacilli. *Microscopical Examination.—Liver,* 13 sections. No caseation. No tubercle bacilli. Not tubercular. B.—Well nourished. *Spleen* showed a few white nodules. All other organs normal. Intestinal tract and all lymph glands normal. No tubercle.

COW 20.

INOCULATION EXPERIMENTS.

Date of Experiment.	Number of Animals.	Meat used.	Killed in or Died in.	Post-mortem Examination.
Aug. 5, 1891 -	1 guinea-pig -	**Rump** (untrimmed).	Died in **3 days** -	Acute septic poisoning from both seats of inoculation. No tubercle anywhere.
Aug. 5, 1891 -	1 guinea-pig -	**Diaphragm** (untrimmed).	Died in **63 days** -	No ulcer at seat of inoculation. No enlargement of inguinal or any other lymph glands. Lungs were congested. All other organs normal. Intestinal tract normal. No tubercle anywhere.

FEEDING EXPERIMENTS.

Date of Experiment.	Number of Animals.	Amount Eaten.	Meat used.	Duration of Feeding.	Killed in or Died in.	Post-mortem Examination.
Aug. 5 891 -	4 guinea-pigs.	908 grams -	**Rump** (untrimmed).	4 days -	A. died in **13 days** - B. died in **13 days** - C. died in **39 days** - D. died in **86 days** -	A.—Showed congestion of lungs. No tubercle in any organ, lymph gland, or in the intestinal tract. B.—Showed congestion of lungs. Nil elsewhere. **Tuberculosis.** C.—Lungs, heart, kidneys, and serous membranes normal. The *small intestine* showed in the mucous membranes about 20 deposits of tubercle of about 2 mm. in diameter, two or three of which had ulcerated. Two Peyer's patches were enlarged, yellow, and superficially ulcerated. One of these patches was near the cæcum, the other near the duodenum. Rest of patches normal. The *large intestine* showed all the Peyer's patches in the cæcum to be enlarged, hard, yellow, but not ulcerated. There were also deposits of tubercle in the mucous membrane between the patches, one or two of which deposits were ulcerated. There were also two small deposits of tubercle in the ascending colon. Rectum normal. *Mesenteric glands* were greatly enlarged and almost completely caseated. The glands around the cæcum were also enlarged, and showed deposits of tubercle. Other lymph glands normal. The *liver* and *spleen* each showed seven or eight miliary tubercles, the size of a pin's head. *Microscopical Examination. — Mesenteric glands,* six sections; showed advanced caseous tubercle. T.B. x. D.—Lungs showed patches of collapse. All other organs normal. All lymph glands normal. The *duodenum* just beyond pylorus showed a transverse oval yellow gangrenous ulcer, about $\frac{1}{3}$ inch across, which had perforated. There was some local peritonitis outside. The glands in the neighbourhood were slightly enlarged and yellowish. The rest of the gut was normal. *Microscopical Examination.—Duodenal ulcer,* nine sections; showed an ulcer in the mucous membrane. Basement membrane intact. In the slough numerous diplococci and streptococci were found. No tubercle bacilli.

Date of Experiment.	Number of Animals.	Amount Eaten.	Meat used.	Duration of Feeding.	Killed in or Died.	Post-mortem Examination.
Aug. 5, 1891 -	4 guinea-pigs.	908 grams -	**Diaphragm** and **Intercostals** (untrimmed).	4 days -	A. died in **13 days** - B. died in **13 days** - C. died in **13 days** -	A., B., C.—All showed congestion of lungs. All other organs were normal. All lymph glands and the intestinal tract normal. No tubercle.
					D. died in **83 days** -	**Tuberculosis.** D.—*Lungs* congested. Numerous deposits of yellowish tubercle. *Liver* enlarged and congested. Showed several large caseous areas. *Spleen* enlarged. Numerous small caseous areas. *Cœcal glands, mesenteric* and *bronchial* were enlarged and caseous. There were numerous small tubercles in the *mesentery*, but no general peritonitis. *Small intestine* showed two ulcers and three deposits of tubercle in the mucous membrane of the ileum. *Cœcum* showed seven deposits in the Peyer's patches. No ulceration. Colon, rectum, and stomach normal. *Microscopical Examination. — Mesenteric gland,* seven sections. Showed caseous tubercle. T.B. x.
Aug. 5, 1891 -	2 pigs -	2,381 grams -	**Rump** (untrimmed).	3 days -	A. killed in **82 days**	**Tuberculosis.** A.—*Serous membranes.*—Normal. *Lungs.*—One doubtful tubercular nodule. *Liver.*—Showed seven small nodules, yellowish and caseous on section. *Spleen. Heart. Kidneys and Suprarenals.*—All quite normal. *Lymph glands.*—Posterior mediastinal, bronchial, and mesenteric normal. Others not examined. *Intestines.*—One of the Peyer's patches showed a small nodule. The rest of the intestines both large and small were normal. *Microscopical Examination. — Lung,* 13 sections. Showed a nodule of caseous tubercle, T.B. x. *Liver,* nine sections. Showed a nodule of round cells with bacteria. No caseation. No tubercle bacilli. Not tubercular. *Peyer's patch,* 32 sections. Normal lymphoid tissue, with a few necrosed cells and bacteria. No tubercle bacilli. Not tubercular.
					B. killed in **203 days.**	**Tuberculosis.** B.—*Serous membranes.*—Normal. *Lungs.*—There were a few transparent nodules 2 to 3 mm. in diameter on the surface. *Liver.*—Showed a few small white nodules on the surface. *One epididymis.*—Showed caseous tubercle on section. *Heart, spleen, kidneys, and suprarenals.*—Normal. *Lymph glands.*—Some *mediastinal* and *bronchial* glands were caseous. Some glands between the folds of the large intestine were affected with tubercle and caseous. The glands in the lesser omentum were caseous and calcareous. All other lymph glands were quite normal. *Intestines.*—There were two small superficial ulcers on the ileo-cæcal valve. The rest of the intestines both large and small were normal.
						Microscopical Examination :— *Gland between folds of large gut,* 12 sections. Caseation. T.B. x. *Cœliac gland,* nine sections. Numerous foci of caseous tubercle. T.B. x. *Bronchial gland,* nine sections. Caseous tubercle. No tubercle bacilli. *Ileo-cæcal valve,* 10 sections. No tubercle. *Lung,* nine sections. No tubercle. *Liver,* nine sections. No tubercle. February 24, 1892.—A guinea-pig was inoculated in the right groin with the caseous material from a gland of this pig (gland in lesser omentum). The guinea-pig was killed 92 days after inoculation and showed an ulcer at the seat of inoculation, and caseous inguinal (both sides), lumbar (both sides), cœliac, bronchial, mediastinal, and cervical glands; and tubercle of lungs, liver, and spleen. Other organs and glands normal. *Cover-slip preparations of lumbar gland.*—T.B. xx. May 26, 1892.—A guinea-pig was inoculated in both groins with the caseous material of a lumbar gland from the last guinea-pig. The animal died in 62 days, and showed caseous glands at both seats of inoculation and caseous inguinal, lumbar, cœliac, and bronchial glands. The liver and spleen were extensively, and the lungs slightly, affected with tubercle. *Microscopical Examination.—Local lesion,* 10 sections. Caseous tubercle. T.B. *Inguinal gland,* 12 sections.—Caseation. T.B. x.

COW 21.

INOCULATION EXPERIMENTS.

Date of Experiment.	Number of Animals.	Meat used.	Killed in or Died in.	Post-mortem Examination.
Feb. 10, 1892	2 guinea-pigs	**Rump** (untrimmed).	A. died in **22 days**	A.—There was thickening of the tissues and some old hæmorrhage at the seat of inoculation on the right side. No lymph glands in the neighbourhood were affected. On the *left* side at the *seat of inoculation* there were two lymph glands enlarged and caseous on section. The lumbar glands on the left side were enlarged but not caseous. Other organs and glands normal. *Microscopical Examination.–Local lesion right side,* eight sections. Large areas of necrosing round cells in the connective tissue and muscle fibres. Completely necrotic areas due to numerous bacilli which also block vessels. Bacterial necrosis. No tubercle bacilli. Not tubercular.
			B. died in **22 days**	B.—There was some slight thickening of the tissues at the seat of inoculation on the right side, and no enlargement of the lymph glands on that side. On the left side over the seat of inoculation there was a small circular ulcer, with a great thickening of the tissues at its base. This thickening was seen on section to be composed of a small chain of caseous glands. All other glands and all organs were normal. Four *cover-slip preparations* of the caseous material were made. No tubercle bacilli. Unfortunately the caseous glands were mislaid, so that no sections were available for microscopical examination.

FEEDING EXPERIMENTS.

Date of Experiment.	Number of Animals.	Amount Eaten.	Meat used.	Duration of Feeding.	Killed in or Died in.	Post-mortem Examination.
Feb. 9, 1892	4 guinea-pigs.	574 grams	**Rump** (untrimmed).	6 days	A. died in **8 days**	A.—Broncho-pneumonia ; all other organs and all lymph glands normal. Intestines normal. No tubercle.
					B. died in **8 days**	B.—Pneumonia of both lungs. Intestines, lymph glands, and other organs normal. No tubercle.
					C. died in **33 days**	**Tuberculosis.** C.—Lungs showed broncho-pneumonia. Other organs normal. The *jejunum* showed a small collection of tubercles at one spot only. The rest of the intestine was normal. There was enlargement and caseation of one of the *mesenteric glands.* Other glands normal. *Microscopical Examination. — Mesenteric gland,* 16 sections showed caseous tubercle in an early stage. T.B. x x.
					D. died in **33 days**	D.—Lungs showed pneumonia. All other organs normal. Intestines and all lymph glands normal. No tubercle.
Feb. 9, 1892	4 guinea-pigs.	474 grams	**Rump** (untrimmed).	6 days	A. died in **3 days**	A. B. C. D. Lungs pneumonic; all other organs normal. All lymph glands normal. Intestinal tract normal. None of the animals showed any tubercle.
					B. died in **4 days**	
					C. died in **33 days**	
					D. died in **33 days**	
Feb. 10. 1892	2 pigs	8,100 grams	**Rump** (untrimmed).	3 days	A. killed in **106 days.**	**Tuberculosis.** A.—*Serous membranes,* normal. *Lungs, tonsils* and *larynx, kidneys* and *suprarenals, uterus* and *ovaries* were normal. *Liver* showed four or five hard white nodules on surface, not caseating. *Spleen* showed four caseating whitish nodules on the surface. *Lymph glands.— At angle of jaw,* caseo-calcareous tubercle. *Cœliac.* Caseo-calcareous tubercle. The inguinal, lumbar, in lesser omentum, mediastinal, bronchial, deep cervical, popliteal, colic, cæcal, and mesenteric glands were all quite normal. *Intestines* were normal and contained a nematode worm. *Microscopical Examination.—Liver* 11 sections. Commencing caseous tubercle. T.B. x. *Gland below jaw,* 9 sections. Caseous tubercle. T.B. x. *Cœliac gland,* 10 sections. Caseous tubercle. T.B. x. *Spleen,* 7 sections. Fibro-caseous tubercle. No tubercle bacilli.
					B. killed in **139 days.**	B.—*Serous membranes,* normal. *Organs,* all normal. *Lymph glands,* all normal. *Intestines,* normal. There was no tubercle anywhere.

COW 22.

INOCULATION EXPERIMENTS.

Date of Experiment.	Number of Animals.	Meat used.	Killed in or Died in.	Post-mortem Examination.
July 28, 1892 -	2 guinea-pigs -	**Rump** (trimmed).	A. died in **17 days** - B. killed in **70 days**	A.—Nothing abnormal at seats of inoculation. All lymph glands normal. Pneumonia. Other organs normal. No tubercle. B.—All organs and lymph glands normal. Nothing abnormal at seats of inoculation. No tubercle.
July 28, 1892 -	2 guinea-pigs -	**Rump** (untrimmed).	A. } B. } killed in **70 days.**	A. } B. } Nothing abnormal at seats of inoculation in either guinea-pig. All lymph glands and organs normal. No tubercle.
July 28, 1892 -	2 guinea-pigs	Meat-juice from **Rump** (trimmed). 1 cc. right groin, A. 1 cc. each groin, B.	A. died in **16 days** - B. died in **52 days** -	**Tuberculosis.** A.—There was a large abscess on the right side at the seat of inoculation. No glands wese enlarged, and no organs were affected. *Microscopical Examination.—Local lesion,* 10 sections. Mixed infection of cocci and other bacteria. A few tubercle bacilli seen. Tubercular. **Tuberculosis.** B.—From both seats of inoculation there extended up enlarged and caseous glands as follows: *inguinal, lumbar, cœliac, bronchial* and *mediastinal* and *cervical*. The *liver* and *spleen* were studded with tubercle. Lungs normal. Intestines and mesenteric glands normal. Nil elsewhere. *Microscopical Examination.—Spleen,* 12 sections. Caseous tubercle. T.B. xx. *Liver,* eight sections. Caseous tubercle. T.B. xx.
July 28, 1892 -	2 guinea-pigs	Meat-juice from **Rump** (untrimmed). Each, 1 cc. each groin.	A. died in **2 days** - B. died in **34 days** -	A.—Died of acute septicæmia. No tubercle at seats of inoculation or in any organ or lymph gland. B.—Broncho-pneumonia. Nil at either seat of inoculation. All other organs and all lymph glands normal.

FEEDING EXPERIMENTS.

Date of Experiment.	Number of Animals.	Amount Eaten.	Meat used.	Duration of Feeding.	Killed in or Died in.	Post-mortem Examination.
July 27, 1892	4 guinea-pigs.	400 grams -	**Rump** (trimmed).	4 days -	A. died in **17 days** - B. died in **33 days** - C. died in **35 days** - D. killed in **76 days**	A.—There was no tubercle in any of the organs, lymph glands, or intestines. B.—Lungs pneumonic. No tubercle in any of the organs, lymph glands, or intestines. C.—Broncho-pneumonia. No tubercle in any of the organs, lymph glands, or intestines. D.—All organs, lymph glands, and intestines were quite normal. No tubercle.
July 27, 1892	4 guinea-pigs.	350 grams -	**Rump** (untrimmed).	4 days -	A. died in **23 days** - B. died in **37 days** - C. died in **50 days** - D. killed in **76 days**	A.—Pneumonia. There was no tubercle in any of the organs, lymph glands, or intestines. B.—Broncho-pneumonia. There was no tubercle in any of the organs, lymph glands, or intestines. C.—All organs were normal. The *cæcal glands* were enlarged and caseous. Mesenteric glands normal. There were several white patches in the mucous membrane of the small intestine. *Microscopical Examination.*—Five cover-slip preparations of the caseous matter of the cæcal gland. Numerous bacteria. No tubercle bacilli. *Cæcal gland.*—12 sections. Bacterial necrosis of gland tissue. Bacteria blocking vessels round necrosed area. No tubercle bacilli. *Small gut.*—38 sections. No tubercular structure. No tubercle bacilli. D.—All lymph glands, organs, and intestines, were quite normal. There was no tubercle anywhere.
July 27, 1892	1 pig -	3,000 grams -	**Rump** (trimmed).	3 days -	Killed in **135 days**	*Serous membranes.*—All normal. *Organs.—Liver* showed a small nodule on its upper surface of a doubtful nature. *Spleen, heart, lungs, kidneys. suprarenals,* and *thryoid* were normal. *Tongue, tonsils,* and *larynx* normal. *Lymph glands.—Mesenteric.* One only showed some doubtful nodules of about the size of a pin's-head. The cervical, mediastinal, bronchial, cœliac, and lumbar glands, and the glands in the lesser omentum were all quite normal. *Intestines.*—Both the large and the small gut were normal. *Microscopical Examination.—Liver,* 10 sections. Area of softened liver cells at surface. No caseation. No tubercle bacilli. Not tubercular. *Mesenteric gland.*—10 sections. Three or four areas of necrosing cells. No tubercle bacilli. Not tubercular.

COW 23.

INOCULATION EXPERIMENTS.

Date of Experiment.	Number of Animals.	Meat used.	Killed in or Died in.	Post-mortem Examination.
Feb. 20, 1893	2 guinea-pigs	**Rump** (trimmed).	A. died in **17 days**	A.—There was nothing to be seen at either seat of inoculation, and the inguinal and lumbar glands were quite normal. The *mesenteric, cœliac, cæcal,* and *anterior mediastinal* glands were greatly enlarged and caseous. The *liver* and *spleen* contained numcrous round nodules with soft cheesy contents. There were two similar nodules in the base of the left *lung*. The intestines and the remaining organs were quite normal. *Microscopical Examination.*—Six cover-slip preparations were made of glands. Leucocytes and cocci. No tubercle bacilli. *Liver.*—10 sections. Necrosis of liver cells, and small-celled infiltration. Numerous bacilli. No tubercle bacilli. Bacterial necrosis. *Mesenteric gland.*—12 sections. Necrosis of gland. Bacilli as in liver. No tubercle bacilli. Bacterial necrosis.
			B. killed in **days**	**Tuberculosis.** B.—At the seat of inoculation on the right side was a large caseous mass and the *inguinal* and *lumbar* glands on that side were enlarged and caseous. *Spleen* and *liver* showed some tubercular nodules. Other organs and lymph glands normal. *Microscopical Examination.*—One cover-slip preparation of local lesion. Caseous material. T.B. x.
Feb. 20, 1893	2 guinea-pigs	**Rump** (untrimmed).	A. killed in **56 days**	**Tuberculosis.** A.—At each seat of inoculation was a large caseous mass, and the *inguinal, lumbar,* and *cœliac* glands on both sides were caseous, as were also the *anterior mediastinal*. The *liver* and *spleen* were tubercular. No other organs or lymph glands were affected. *Microscopical Examination.*—Two cover-slip preparations of local lesion. A few tubercle bacilli were found.
			B. killed in **56 days**	B.—At seat of inoculation on the left side was a large caseous mass, and the left *inguinal,* left *lumbar,* and the *cœliac glands* were caseous. The *spleen* was slightly affected with tubercle. All other organs and lymph glands were normal. *Microscopical Examination.*—Two cover-slips preparations of the local lesion showed T.B. xx.

FEEDING EXPERIMENTS.

Date of Experiment.	Number of Animals.	Amount Eaten.	Meat used.	Duration of Feeding.	Killed in or Died in.	Post-mortem Examination.
Feb. 18, 1893	1 pig	4,645 grams	**Rump** (trimmed).	5 days	Killed in **67 days**	**Tuberculosis.** *Serous membranes* were all normal. *Organs.*—In the lower lobe of the *right lung* was a small nodule the size of a pea, caseous on section. In the *liver* was a small nodule, white with a yellow centre. *Heart, spleen, kidney, suprarenals, thyroid,* and all other organs were normal. A little to the left of the middle line situated at the base of the tongue about $\frac{3}{4}$ inch above the epiglottis was a small yellow nodule about the size of a split pea. The *tonsils* both showed a few yellow points about the size of a pin's head. *Lymph glands.*—The gland at the angle of the right jaw showed in cortex streaky caseation. All other lymph glands were normal. *Intestines* were quite normal. *Microscopical Examination.*—*Pharyngeal nodule,* 17 sections. A necrotic area surrounded by leucocytes. Pure culture of streptococi in and around necrotic area. No tubercle bacilli. Bacterial necrosis (*see* Plate IV.) *Tonsil,* 14 sections. Normal. *Gland below jaw,* eight sections. Caseous tubercle. T.B. x. Numerous streptococi. *Lung,* 10 sections. An isolated nodule at the surface; areas of necrosis with a few cocci. No tubercle bacilli. Bacterial necrosis.
Feb. 18, 1893	1 pig	4,970 grams	**Rump** (untrimmed).	5 days	Killed in **67 days**	*Serous membranes* were all normal. *Organs.*—*Lungs, heart, liver, spleen, kidneys suprarenals,* and *thyroid* were all quite normal. *Lymph glands.*—Cervical, mediastinal, bronchial, cœliac, lumbar, and mesenteric glands were normal. *Intestines.*—Both large and small were normal. At about the junction of the pharynx with the œsophagus, a little to the left of the middle line, was a small yellow nodule about the size of a pea. *Microscopical Examination.* — *Pharyngeal nodule,* 12 sections. Area of necrosis; pure culture of streptococus. No tubercle bacilli Bacterial necrosis.

INQUIRY II.

PART VIII.

DETAILS OF THE EXPERIMENTS WITH MILK.

1. With the milk of *eight cows* the subject of tuberculosis of the internal organs, but without disease of the udder (tuberculous or otherwise).
2. With the milk of *five cows* the subject of tuberculosis of the internal organs, and with tuberculous disease of the udder.
3. With the milk of *two cows,* the subject of tuberculosis of the internal organs and with non-tuberculous disease of the udder.
4. With the milk of two cows, with non-tuberculous disease of the udder and no tuberculosis of the internal organs.

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1. Experiments with the milk of eight cows the subject of tuberculosis of the internal organs but without disease of the udder (tuberculous or otherwise), to test the infectivity of the milk by feeding and inoculating animals with it.

Mild tuberculosis	Cow No. 7	1 Cow.
Moderate tuberculosis	Cows No. 11, 12, 13, 15, 16	5 Cows.
Advanced and generalised tuberculosis	Cows No. 22, 23	2 Cows.

COW 7.

INOCULATION EXPERIMENTS.

Date of Experiment.	Number of Animals.	Where Inoculated.	Killed in or Died in.	Post-mortem Examination.
Oct. 23, 1892	2 guinea-pigs	1 cc. subcutaneously in each groin.	A. died in **38 days**	A.—Lungs showed broncho-pneumonia. There was nothing abnormal to be seen at either seat of inoculation. There was no tubercle or other evident disease in any other organ or in the lymph glands.
			B. died in **39 days**	B.—Lungs were extensively affected with pneumonia. There was nothing abnormal to be seen at either seat of inoculation, and there was no tubercle or other evident disease in any of the organs or lymph glands.

FEEDING EXPERIMENTS.

Date of Experiment.	Number of Animals.	Quantity taken.	Milk from.	Duration of Feeding.	Killed in or Died in.	Post-mortem Examination.
Oct. 23, 1892	4 guinea-pigs.	3,425 cc.	All quarters of the udder.	26 days	A. died in **34 days**	A.—Liver showed a few white specks on the surface. There was no tubercle or any other evident disease in any other organ, or in the lymph glands or intestines.
					B. died in **39 days**	B.—Lungs were affected with pneumonia. There was no tubercle or any other evident disease in any other organ, or in the lymph glands or the intestines.
					C. died in **39 days**	C.—There was no tubercle or any other evident disease in any organ, or in any of the lymph glands or the intestines.
					D. died in **45 days**	D.—There was no tubercle or any other evident disease in any organ, or in any of the lymph glands or the intestines.
Oct. 31, 1892	4 guinea-pigs.	1,725 cc.	All quarters of the udder.	18 days	A. died in **11 days**	A.—The liver and the gall-bladder were affected with advanced bacterial disease. There was no tubercle or other evident disease in any other organ, or in the lymph glands or intestines. *Microscopical Examination.—Liver,* 19 sections. Showed large areas of cell-necrosis. Very numerous bacilli in the necrotic areas. No tubercle bacilli. Bacterial necrosis.
					B. died in **34 days**	B.—Lungs showed broncho-pneumonia. There was no tubercle or other evident disease in any other organ, or in the lymph glands or intestines.
					C. died in **34 days**	C.—Lungs was affected with broncho-pneumonia. There was no tubercle or other evident disease in any other organ, or in the lymph glands or intestines.
					D. died in **37 days**	D.—Lungs were affected with broncho-pneumonia. There was no tubercle or other evident disease in any other organ, or in the lymph glands or intestines.

COW 11.

INOCULATION EXPERIMENTS.

Date of Experiment.	Number of Animals.	Where Inoculated.	Killed in or Died in.	Post-mortem Examination.
August 5, 1892 -	1 rabbit - -	5 cc. subcutaneously in each groin.	Killed in **68 days**	There was no local lesion. Liver showed whitish areas (parasitic) and there were numerous cysts attached to the omentum. There was no tubercle or other evident disease in any other organ or in any lymph gland.
August 9, 1892 -	2 guinea-pigs -	1 cc. subcutaneously in each groin.	A. killed in **64 days** B. killed in **64 days**	A. B. Both animals were very fat and well nourished. There was nothing abnormal to be seen at any of the seats of inoculation, and there was no tubercle or other evident disease anywhere.

FEEDING EXPERIMENTS.

Date of Experiment.	Number of Animals.	Quantity taken.	Milk from.	Duration of Feeding.	Killed in or Died in.	Post-mortem Examination.
Aug. 3, 1892 -	4 guinea-pigs.	4,950 cc. - -	All quarters of the udder.	33 days -	A. died in **16 days** B. died in **64 days** C. died in **75 days** D. died in **75 days**	A.—Lungs were affected with broncho-pneumonia. There was no tubercle or other evident disease in the intestines or lymph glands, or in any other organ. B.—Lungs showed large patches of pneumonic consolidation. There was no tubercle or other evident disease in any other organ, or in the intestines or lymph glands. C.—Lungs were slightly affected with broncho-pneumonia. There was no tubercle or other evident disease in any other organ, or in the intestines or lymph glands. D.—Liver showed whitish areas. There was no tubercle or other evident disease in any other organ, or in the intestines or lymph glands. *Microscopical Examination.—Liver*, 10 sections. Showed areas with a large number of cocci in the vessels. Some necrosis of cells. No tubercle bacilli. Bacterial necrosis.
Aug. 3, 1892 -	1 rabbit	6,450 cc. -	All quarters of the udder.	33 days -	Killed in **141 days**	There were some parasitic cysts attached to the omentum. The animal was very well nourished. There was no tubercle or other evident disease in any organ, or in the intestines or lymph glands.

COW 12.

INOCULATION EXPERIMENTS.

Date of Experiment.	Number of Animals.	Where Inoculated.	Killed in or Died in.	Post-mortem Examination.
Oct. 7, 1892 - -	1 rabbit - -	5 cc. subcutaneously in each groin.	Killed in **63 days** -	Animal was very fat and well nourished. There was nothing abnormal to be seen at either seat of inoculation, and there was no tubercle or other evident disease in any organ or lymph gland.
Oct. 7 1892 - -	2 guinea-pigs -	2 cc. subcutaneously in each groin.	A. died in **28 days** B. died in **47 days**	A.—Lungs were inflamed. There was nothing to be seen at either seat of inoculation, and there was no tubercle or other evident disease in any other organ or lymph gland. B.—Lungs were slightly affected with broncho-pneumonia. At the seat of inoculation on the left side was a small hard mass, and near it was a somewhat enlarged and hardened gland. There was no tubercle or other evident disease elsewhere. *Microscopical Examination.—Gland*, 12 sections. Hyperplasia of lymphoid tissue of gland with thickening of the connective tissue around. No caseation. No tubercle bacilli. Not tubercular.

FEEDING EXPERIMENTS.

Date of Experiment.	Number of Animals.	Quantity taken.	Milk from.	Duration of Feeding.	Killed in or Died in.	Post-mortem Examination.
Oct. 7, 1892 -	4 guinea-pigs.	1,270 cc. - -	All quarters of the udder.	13 days -	A. died in **18 days** B. died in **18 days** C. died in **18 days** - D. died in **48 days**	A.—The lungs were affected with pneumonia and the liver with commencing parasitic disease. There was no tubercle or other evident disease in any other organ, or in any of the lymph glands or intestines. *Microscopical Examination.—Liver*, 22 sections. A few areas of necrosis. No tubercle bacilli. No tubercular structure. B.—The lungs were affected with pneumonia, and there was commencing parasitic disease in the liver and spleen. There was no tubercle or other evident disease in any other organ, or in the lymph glands or intestines. C.—Lungs showed slight broncho-pneumonia. There was no tubercle or other evident disease in any other organ, or in the lymph glands or intestines. D.—There was no tubercle or other evident disease in any of the organs, lymph glands, or intestines.

Date of Experiment.	Number of Animals.	Quantity taken.	Milk from.	Duration of Feeding.	Killed in and Died in.	Post-mortem Examination.
Oct. 7, 1892 -	4 guinea-pigs.	1,270 cc. - -	All quarters of the udder.	13 days -	A. died in **20 days**	A.—The heart showed in the anterior interventricular groove a small parasitic cyst. There was no tubercle or other evident disease in any other organ, or in the lymph glands or intestines.
					B. died in **42 days**	B.—Lungs were affected with broncho-pneumonia. There was no tubercle or other evident disease in any other organ; or in any of the lymph glands or intestines.
					C. died in **47 days** -	C.—Lungs showed pneumonia. There was no tubercle or other evident disease in any other organ, or in the lymph glands or intestines.
					D. died in **48 days**	D.—Lungs showed pneumonia. There was no tubercle or other evident disease in any other organ, or in the lymph glands or intestines.
Oct. 7, 1892 -	1 rabb -	1,290 cc. - -	All quarters of the udder.	13 days -	Killed in **102 days**	The animal was very fat and well-nourished. There was no tubercle or other evident disease in any of the organs, lymph glands or intestines.
Oct. 8, 1892 -	1 pig - -	7,660 cc. - -	All quarters of the udder.	12 days -	Killed in **113 days**	*Serous membranes* :— Pleuræ, Pericardium, Peritoneum, } were all normal. *Organs* :— Heart, Lungs, Liver, Spleen, Kidneys, Suprarenals, Thyroid, Thymus, } all quite normal. The salivary glands, tongue, and tonsils were normal. *Lymph glands* :— Below jaw, Cervical, Bronchial, Mediastinal, In lesser omentum, Cœliac, Cæcal, Lumbar, Mesenteric, } all quite normal. *Intestines*.—The intestinal tract was quite normal.

COW 13.

Inoculation Experiments.

Date of Experiment.	Number of Animals.	Where Inoculated.	Killed in or Died in.	Post-mortem Examination.
Oct. 23, 1892 -	2 guinea-pigs -	1 cc. subcutaneously in each groin.	A. died in **3 days** -	A.—Lungs showed pneumonia. There was some unabsorbed milk at the seats of inoculation. There was no tubercle or other evident disease in any other organ or in the lymph glands.
			B. died in **35 days** -	B.—There was nothing abnormal to be seen at either seat of inoculation, and there was no tubercle or other evident disease in any organ or lymph gland.
Oct. 28, 1892 -	1 guinea-pig -	1 cc. subcutaneously in each groin.	Died in **29 days** -	Lungs showed pneumonia. There was nothing abnormal to be seen at either seat of inoculation, and there was no tubercle or other evident disease in any other organ or lymph gland.

Feeding Experiments.

Date of Experiment.	Number of Animals.	Quantity taken.	Milk from.	Duration of Feeding.	Killed in or Died in.	Post-mortem Examination.
Oct. 23, 1892 -	4 guinea-pigs.	484 cc. - -	All quarters of the udder.	9 days -	A. died in **10 days**	A.—Lungs showed pneumonia. There was no tubercle or any other evident disease in any other organ, or in the intestines or lymph glands.
					B. died in **12 days**	B.—Lungs showed pneumonia. There was no tubercle or any other evident disease in any other organ, or in the intestines or lymph glands.
					C. died in **34 days** -	C.—Lungs showed broncho-pneumonia There was no tubercle or any other evident disease in any other organ, or in the intestines or lymph glands.
					D. died in **38 days**	D.—Lungs showed broncho-pneumonia. There was no tubercle or any other evident disease in any other organ, or in the intestines or lymph glands.

COW 15.

INOCULATION EXPERIMENTS.

Date of Experiment.	Number of Animals.	Where Inoculated.	Killed in or Died in.	Post-mortem Examination.
June 29, 1892	2 guinea-pigs	1 cc. subcutaneously in each groin.	A. died in **20 days** B. died in **22 days**	A.—At the seat of inoculation on the left side was a soft yellow nodule, 2 × 6 mm. No glands were in any way affected. There was no tubercle or other evident disease in any organ. B.—At the seat of inoculation on the left side the glands were somewhat enlarged. They were not caseous on section. The spleen was affected with parasitic disease. There was no tubercle or other evident disease in any other organ or lymph gland. *Microscopical Examination.—Local lesion,* six sections. Normal lymphatic gland tissue with some thickening around. No caseation. No tubercle bacilli. Not tubercular. *Spleen,* four sections. No caseation. No tubercle bacilli. No structure of tubercle.
July 20, 1892	1 rabbit	5 cc. subcutaneously in each groin.	Killed in **70 days**	The animal was very fat and well nourished. There was no tubercle or other evident disease in any of the organs or lymphatic glands.

FEEDING EXPERIMENTS.

Date of Experiment.	Number of Animals.	Quantity taken.	Milk from.	Duration of Feeding.	Killed in or Died in.	Post-mortem Examination.
June 29, 1892	4 guinea-pigs.	3,150 cc.	All quarters of the udder.	21 days	A. died in **5 days** B. died in **35 days** C. died in **37 days** D. died in **37 days**	A.—Lungs were affected with broncho-pneumonia. There was no tubercle or other evident disease in the organs, lymph glands, or intestines. B.—Lungs showed pneumonia. There was no tubercle or other disease in any of the organs, lymph glands, or intestines. C.—Liver showed commencing parasitic disease. There was no tubercle or other obvious disease in any other organ, or in the lymph glands or intestines. *Microscopical Examination.—Liver,* 18 sections. Showed a few areas of necrosis. No caseation. No tubercle bacilli. Not tubercular. D.—The cæcum showed a few opaque areas. There was no tubercle or other evident disease in any of the organs or lymph glands or in any other part of the intestinal tract.
June 29, 1892	1 pig	46,145 cc.	All quarters of the udder.	22 days	Killed in **154 days**	*Serous membranes:—* Pleuræ, Pericardium, Peritoneum, were all normal. *Organs.*—Lungs, heart, liver, spleen, kidneys, suprarenals, thyroid, and thymus were all normal. Tongue and tonsils were normal. *Lymph glands.*—Mesenteric, mediastinal, bronchial, cervical, cœliac, cæcal, and lumbar glands, and the glands in the lesser omentum were all normal. *Intestines.*—The intestinal tract was normal throughout.

COW 16.

INOCULATION EXPERIMENTS.

Date of Experiment.	Number of Animals.	Where Inoculated.	Killed in or Died in.	Post-mortem Examination.
May 11, 1892	1 guinea-pig	1 cc. each groin subcutaneously.	Died in **8 days**	At each seat of inoculation there had been some slight hæmorrhage in the centre of which was a small yellow spot. None of the organs or lymph glands were affected with tubercle. *Microscopical Examination.*—Local lesion, 19 sections. Not tubercular.
May 25, 1892	1 guinea-pig	1 cc. each groin subcutaneously.	Died in **42 days**	There was nothing to be seen at the seats of inoculation, and there was no tubercle or other evident disease in any of the organs or lymph glands.
May 4, 1892	1 guinea-pig	1 cc. intra-peritoneally.	Died in **31 days**	The peritoneum was quite normal, and there was no tubercle or other evident disease in any of the organs, lymph glands or serous membranes.
June 18, 1892	2 guinea-pigs	1 cc. each groin subcutaneously.	A. died in **20 days** B. died in **20 days**	A.—There was nothing abnormal to be seen at either seat of inoculation, and there was no tubercle or other evident disease in any organ or lymph gland. B.—At the seat of inoculation on the left side was a large caseous mass, but nothing on the right side. No glands were in any way abnormal, and there was no tubercle in any organ. *Microscopical Examination.*—Ten cover-glass preparations of caseous material. No tubercle bacilli. *Local lesion.* Nine sections showed a small round-celled infiltration (inflammatory). Necrosis of cells due to numerous cocci and a few bacilli. No tubercle bacilli. Bacterial necrosis.

FEEDING EXPERIMENTS.

Date of Experiment.	Number of Animals.	Quantity taken.	Milk from.	Duration of Feeding.	Killed in or Died in.	Post-mortem Examination.
May 4, 1892 -	4 guinea-pigs.	4,300 cc. -	All quarters of the udder.	35 days -	A. died in **34 days** -	A.—There was no tubercle in any of the organs, lymph glands, or intestines.
					B. died in **42 days** -	B.—Liver showed on its upper surface a small white nodule, and there were several smaller ones in the spleen. All other organs were normal. All lymph glands were normal. A Peyer's patch in the small intestine contained a white diffuse area, and a small nodule was met with in the cæcum. The rest of the intestinal tract was normal. *Microscopical Examination.—Spleen*, 14 sections. No tubercular structure. No caseation. No tubercle bacilli. *Liver.*—Six sections. A small round cell infiltration. Local necrosis. No tubercle bacilli. Not tubercular. *Cæcum*, 18 sections. Not tubercular. *Intestine*, 19 sections. Not tubercular.
					C. died in **55 days** -	C. } The cause of death in both animals was pneumonia. There was no tubercle in any of the organs, lymph glands, or intestines.
					D. died in **63 days** -	D. }
May 4, 1892 -	4 guinea-pigs.	4,200 cc. -	All quarters of the udder.	35 days -	A. died in **6 days** -	A.—The right lobe of the liver was enlarged and contained a large white cheesy mass, and the pylorus was adherent to its under surface. The portal vein was thrombosed, and there was some recent peritonitis. All other organs and the lymph glands and intestines were normal. *Microscopical Examination.—Liver*, 18 sections. Areas of necrosis of liver cells. Small round cell infiltration. No tubercle bacilli. Bacterial necrosis.
					B. died in **36 days** -	B.—Liver and spleen were studded with small white patches. There was no tubercle in any of the other organs, lymph glands, or intestines. *Microscopical Examination.—Liver*, nine sections. Areas of necrosis due to thrombosis of vessels by bacilli. No tubercle bacilli. Bacterial necrosis. *Spleen*, 12 sections. No tubercular structure. No tubercle bacilli.
					C. died in **36 days** -	C.—Liver and spleen showed numerous small white patches. There was no tubercle or other evident disease in the remaining organs, or in the lymph glands or intestines. *Microscopical Examination.—Liver*, nine sections. No tubercular structure. Bacterial necrosis due to plugging of the vessels with bacteria. No tubercle bacilli. *Spleen*, 16 sections. No tubercular structure. No caseation. No tubercle bacilli. A number of other bacilli. Bacterial necrosis.
					D. died in **68 days** -	D.—The spleen was one mass of soft yellowish nodules and resembled the spleen of guinea-pig C. There was no tubercle or other evident disease in any other organ, or in the lymph glands or intestines.
May 4, 1892 -	1 pig -	159,900 cc. -	All quarters of the udder.	41 days -	Killed in **181 days**	The animal was fat and well nourished. *Serous membranes:—* Pleuræ, Peritoneum, Pericardium, } were all normal. *Organs.*—Lungs, heart, liver, spleen, kidneys, suprarenals, uterus, and ovaries, were all normal. Tongue and tonsils were normal. *Lymph glands.*—Mediastinal, bronchial, cœliac, lumbar, cæcal, cervical, and mesenteric glands, and the glands in the lesser omentum were all quite normal. *Intestines.*—Large and small intestines were quite normal.

COW 22.

INOCULATION EXPERIMENTS.

Date of Experiment.	Number of Animals.	Where inoculated.	Killed in or Died in.	Post-mortem Examination.
June 29, 1892 -	2 guinea-pigs -	1 cc. subcutaneously in each groin.	A. died in **23 days** B. died in **29 days**	A. } B. } Slight hæmorrhage at each seat of inoculation. There was no tubercle or other evident disease in any of the organs or lymphatic glands.
July 22, 1892 -	1 rabbit - -	5 cc. subcutaneously in each groin.	Died in **13 days** -	There was a large abscess extending up from the seat of inoculation on the right side to the umbilical region, where it had made its way through the skin. Only the glands near the seat of inoculation were affected, and they were enlarged without any tubercular deposit. There was no tubercle or other evident disease in any of the organs or lymphatic glands. *Microscopical Examination.—Gland near seat of inoculation*, 11 sections. Normal gland tissue. No tubercle bacilli. No caseation. Not tubercular.

FEEDING EXPERIMENTS.

Date of Experiment.	Number of Animals.	Quantity taken.	Milk from.	Duration of Feeding.	Died in or Killed in.	Post-mortem Examination.
June 27, 1892	4 guinea-pigs.	3,400 cc. -	All quarters of the udder.	23 days -	A. died in **26 days**	A. B. C. The cause of death in all these animals was broncho-pneumonia. There was no tubercle or any other evident disease in any other organ, or in the intestines or lymphatic glands.
					B. died in **28 days**	
					C. died in **37 days**	
					D. died in **39 days**	D.—All organs and lymphatic glands were quite normal. The Peyer's patches of the cæcum were thickened and inflamed, but there was no sign of any commencing tubercular deposit. *Microscopical Examination.—Peyer's patch,* 21 sections. Hyperplasia of lymphoid tissue and degeneration of nuclei. No caseation, no tubercle bacilli. Not tubercular.
June 29, 1892	1 pig -	52,003cc. -	All quarters of the udder.	26 days -	Killed in **154 days**	*Serous membranes:—* Pleuræ, Pericardium, Peritioneum, were normal. *Organs.*—The liver showed on its surface a small yellow calcareous spot about 3–4 mm. in diameter. Lungs, heart, spleen, kidneys, suprarenals, thyroid, thymus, ovaries, and uterus were all normal. The tongue, tonsils, and larynx were normal. *Lymph-glands.*—The mediastinal, bronchial, cervical, cæliac, lumbar, and mesenteric glands were quite normal. *Intestines.*—The intestines were normal in every respect. *Microscopical Examination.—Liver nodule,* 15 sections. An area of necrosed liver cells with a fibrous capsule. No tubercle bacilli.

COW 23.

INOCULATION EXPERIMENTS.

Date of Experiment.	Number of Animals.	Where inoculated.	Killed in or Died in.	Post-mortem Examination.
Jan. 14, 1893 -	4 guinea-pigs	1 cc. subcutaneously in right groin.	A. died in **9 days** -	A.—At the seat of inoculation was a caseous mass with considerable thickening of the tissues around. There was no tubercle or other obvious affection of the organs or lymph glands. *Microscopical Examination.—Local lesion,* 8 sections. Inflammatory thickening, hyperplasia of lymphoid tissue. Some necrosis of cells. No tubercle-bacilli. Not tubercular.
			B. died in **13 days**	B.—At the seat of inoculation were three enlarged and hardened glands, which showed no caseous points on section. There was no tubercle or other evident disease of any other lymph glands or organs. *Microscopical Examination.—Local lesion,* 7 sections. Inflammatory hyperplasia of gland tissue and connective tissue around. At one spot there was a small necrotic area. No tubercle-bacilli. Not tubercular.
			C. died in **13 days**	C.—At the seat of inoculation some hæmorrhage had occurred. There were some remains of unabsorbed milk, and one or two caseous points were to be seen. The lymphatic glands close to the seat of inoculation were enlarged and hardened, but were not caseous. There was no tubercle or other evident disease in the seat of the lymphatic glands or in the organs. *Microscopical Examination.—Local lesion,* 9 sections. Inflammatory hyperplasia of gland and connective tissue around. No caseation. No tubercle-bacilli. Not tubercular.
			D. died in **32 days**	D.—Lungs showed broncho-pneumonia. At the seat of inoculation there were some enlarged and hardened glands, but they were not caseous. There was no tubercle or other evident disease of the organs or of any other lymph glands. *Microscopical Examination.—Local lesion,* 21 sections. Inflammatory hyperplasia of gland tissue and connective tissue around. No caseation, but two small areas of necrosing and swollen cells. No tubercle bacilli. Not tubercular.
Jan. 25, 1893 -	4 guinea-pigs	1 cc. Intraperitoneally.	A. died in **13 days**	A.—The lungs showed broncho-pneumonia. There was no peritonitis. There was no tubercle or other evident disease in any other organ or in the lymph glands.
			B. died in **37 days**	B.—The liver showed two yellowish nodules. There was no tubercle or other evident disease in any other organ or in the lymph glands or serous membranes. *Microscopical Examination.—Liver,* 12 sections. Fatty in parts, otherwise nil. No tubercle bacilli. Not tubercular.
			C. died in **37 days**	C.—There was no tubercle or other evident disease in any of the serous membranes, organs, or lymph glands.
			D. died in **37 days**	D.—There was no tubercle or other evident disease in any of the serous membranes, organs, or lymph glands.

FEEDING EXPERIMENTS.

Date of Experiment.	Number of Animals.	Quantity taken.	Milk from.	Duration of Feeding.	Killed in or Died in.	Post-mortem Examination.
Jan. 14, 1893	4 guinea-pigs.	2,700 cc. -	All quarters of the udder.	18 days -	A. died in **16 days** -	A.—Lungs showed broncho-pneumonia. There was no tubercle or other evident disease in any other organ or in the lymph glands or intestines.
					B. died in **23 days** -	B.—The greater part of this animal had been eaten by its fellows. Those parts which remained for examination were not affected with tubercle or any other evident disease.
					C. died in **44 days** -	C.—Lungs showed broncho-pneumonia. There was no tubercle or other evident disease in any other organs or in the lymph glands or intestines.
					D. died in **79 days**	D.—Lungs showed broncho-pneumonia. There was no tubercle or other evident disease in any other organ or in the lymph glands or intestines.

Date of Experiment.	Number of Animals.	Quantity taken.	Milk from.	Duration of Feeding.	Killed in or Died in.	Post-mortem Examination.
Jan. 14, 1893	4 guinea-pigs.	2,700 cc. -	All quarters of the udder.	18 days -	A. died in **23 days** -	A.—Lungs showed extensive inflammation, and the liver showed a few yellowish areas. There was no tubercle or other evident disease in any other organs, or in the lymph glands or intestines. *Microscopical Examination.—Liver,* 16 sections. Fatty liver.
					B. died in **44 days** -	B.—Lungs showed broncho-pneumonia. There was no tubercle or other evident disease in any other organ, or in the lymph glands or intestines.
					C. killed in **94 days**	C.—There was no tubercle or other evident disease in any of the organs, lymph glands, or intestines.
					D. killed in **94 days**	D.—There was no tubercle or other evident disease in any of the organs, lymph glands, or intestines.
Jan. 18, 1893	1 pig - -	56,555 cc. -	All quarters of the udder.	31 days -	Killed in **79 days** -	*Serous membranes:—* Pleuræ, Pericardium, Peritoneum, } normal. *Organs.*—Heart, lungs, spleen, kidneys, supra-renals, thyroid, uterus, and ovaries were all quite normal. *Lymph glands.* — Mediastinal, bronchial, cœliac, cervical, and lumbar glands, and the glands in the lesser omentum were all quite normal. The tongue and tonsils were normal. *Intestines.*—The intestinal tract was normal throughout.

2.—EXPERIMENTS WITH THE MILK OF FIVE COWS, THE SUBJECT OF TUBERCULOSIS OF THE INTERNAL ORGANS, AND WITH TUBERCULOSIS OF THE UDDER.

COWS NOS. 8, 24, 21, 20, 25.

COW 8.

INOCULATION EXPERIMENTS.

Date of Experiment.	Number of Animals.	Material used.	Killed in or Died in.	Post-mortem Examination.
Oct. 30, 1892 -	2 guinea-pigs -	1 cc. sub-cutaneously in each groin from all available quarters of the udder.	A. died in **31 days** -	**Tuberculosis.** A.—There was a caseous mass on the right side at the seat of inoculation. Nil at left side. Both *lumbar glands* were caseous, as were also the *cœliac*. The *posterior mediastinal glands* were enlarged and the lowest of them showed commencing caseation. The *liver* and *spleen* showed several patches of caseous tubercle. Other organs normal, except the lungs which were affected with pneumonia. *Microscopical Examination.—Local lesion,* 10 sections, showed caseous tubercle. T. B. x.
			B. died in **34 days** -	**Tuberculosis.** B.—There was a caseous mass and enlarged and caseous glands at each seat of inoculation. The *inguinal, lumbar,* and *cœliac* glands were caseous, and the *posterior mediastinal glands* were enlarged and showed commencing tubercle. The *liver* and *spleen* showed several patches of caseous tubercle. There was no tubercle elsewhere. *Microscopical Examination.—Local lesion,* 11 sections. Caseous tubercle. T. B. xx.
Oct. 31, 1892 -	2 guinea-pigs -	1 cc. sub-cutaneously in each groin from the left anterior quarter.	A. died in **26 days** -	**Tuberculosis.** A.—At each seat of inoculation was a caseous mass, and the *inguinal* and *lumbar* glands were caseous. *Spleen* showed commencing tubercle, and the lungs were inflamed. There was no tubercle or other evident disease in any other organ or lymph gland. *Microscopical Examination.—Local lesion,* nine sections. Caseating tubercle. T. B. xx.
			B. died in **31 days** -	**Tuberculosis-** B.—At the seat of inoculation on the right side was a caseous mass, and the *inguinal* and *lumbar* glands were caseous. *Liver* and *spleen* showed caseous tubercle and the lungs were pneumonic. There was no tubercle or any other evident disease in any other organ or lymph glands. *Microscopical Examination.*—Two cover-glass preparations were made of the caseous material. T. B. xx.
Nov. 23, 1892 -	2 guinea-pigs -	1 cc. sub-cutaneously in each groin from all available quarters.	A. died in **9 days** -	**Tuberculosis.** A.—There was a caseous gland at the seat of inoculation on the right side. The lungs showed broncho-pneumonia. There was no tubercle or other evident disease in any other organ or lymph gland. *Microscopical Examination.*—Cover-glass preparations of caseous material of the local lesion showed tubercle bacilli, but 13 sections were cut of the tissue around and showed no tubercle bacilli.
			B. died in **25 days** -	**Tuberculosis.** B.—There was a caseous mass at each seat of inoculation, and the *inguinal* and *lumbar* glands on each side were caseous. The cœliac and mediastinal glands were enlarged, but not obviously tubercular. The *liver* and *spleen* showed numerous patches of tubercle. There was no tubercle or other evident disease in any other organ or lymph gland. *Microscopical Examination.*—Cover-glass preparations of the caseous material of the local lesion showed numerous tubercle bacilli.

Date of Experiment.	Number of Animals.	Material used.	Killed in or Died in.	Post-mortem Examination.
Nov. 2, 1892	2 guinea-pigs	Subcutaneously, in each groin with some discharge from the ulcer on the udder.	A. died in **34 days**	**Tuberculosis.** A.—There were caseous glands on each side at the seat of inoculation, and the lumbar glands were enlarged and caseous. The spleen showed one or two nodules of tubercle. There was no tubercle or other evident disease in any other organ or lymph gland. *Microscopical Examination:*— *Local lesion.* Caseous tubercle. T. B. xxx. *Spleen* showed three or four foci of caseous tubercle. T. B. xx.
			B. died in **35 days**	**Tuberculosis.** B.—There were caseous glands at each seat of inoculation, but the inguinal and lumbar glands were caseous on the left side only. The spleen showed a few doubtful nodules. No tubercle elsewhere. *Microscopical Examination:*— *Local lesion,* nine sections showed caseous tubercle. T. B. xxx. *Spleen,* 10 sections. No caseation. No tubercular structure. No tubercle bacilli.

FEEDING EXPERIMENTS.

Date of Experiment.	Number of Animals.	Quality taken.	Milk from.	Duration of Feeding.	Died in or Killed in.	Post-mortem Examination.
Oct. 20, 1892	4 guinea-pigs.	1,900 cc.	All available quarters of the udder.	19 days	A. died in **18 days**	A.—Lungs were affected with broncho-pneumonia. There was no tubercle or other evident disease in any other organ, or in any of the lymph glands or intestines.
					B. died in **32 days**	**Tuberculosis.** B.—Lungs showed pneumonia. All other organs and all lymph glands were normal. The lower part of the ileum showed 12 small white nodules about the size of a pin's head in the mucous membrane. The rest of the intestines were normal. *Microscopical Examination.*—10 sections of a nodule in the ileum showed a collection of large round cells, and one or two giant cells. No caseation. A few tubercle bacilli were found.
					C. died in **33 days**	**Tuberculosis.** C.—Lungs showed pneumonia. All other organs and lymph glands were normal. About 2 inches above the cæcum was a small white nodule in the mucous membrane. The rest of the intestine was normal. *Microscopical Examination.*—A *Peyer's patch* near nodule, 26 sections, normal. *Nodule* showed tubercular structure with a few tubercle bacilli.
					D. died in **38 days**	D.—Lungs showed pneumonia. There was no tubercle or other evident disease in any other organ, or in any of the lymph glands or intestines.
Oct. 30, 1892	4 guinea-pigs.	1,900 cc.	All available quarters.	19 days	A. died in **32 days**	**Tuberculosis.** A.—Lungs showed pneumonia. A few Peyer's patches in the intestine were enlarged, but showed no evident tubercular deposit. There was no tubercle or other evident disease elsewhere. *Microscopical Examination.—Peyer's patch,* 15 sections were normal. Other sections showed tubercular structure, with a few tubercle bacilli. No caseation.
					B. died in **32 days**	B.—Lungs showed pneumonia, and the liver showed a doubtful nodule. There was no tubercle or other evident disease in any other organ, or in the intestines or lymph glands. *Microscopical Examination.—Liver,* 19 sections. An early necrosis of liver cells. No tubercle bacilli. Not tubercular.
					C. died in **34 days**	C.—Small intestine showed, between its lowest two Peyer's patches, 14 small nodules. There was no tubercle or other evident disease in the rest of the intestines, or in the organs or lymph glands. *Microscopical Examination.*—Nodules, 21 sections. No tubercle bacilli.
					D. died in **35 days**	D.—Lungs showed pneumonia. There was no tubercle or other evident disease in any other organ, or in the lymph glands or intestines.
Oct. 31, 1892	4 guinea-pigs.	1,800 cc.	Left anterior quarter.	18 days	A. died in **9 days**	A.—Both bases of the lungs were greatly engorged with blood. There was no tubercle or other evident disease in any other organ or in the intestines or lymph glands.
					B. died in **23 days**	B.—Lungs showed broncho-pneumonia. There was no tubercle or other evident disease in any other organ or in the intestines or lymph glands.
					C. died in **28 days**	C.—Lungs showed broncho-pneumonia. There was no tubercle or other evident disease in any other organ or in the intestines or lymph glands.
					D. died in **35 days**	D.—Lungs showed broncho-pneumonia. There was no tubercle or other evident disease in any other organ, or in the intestines or lymph glands.
Oct. 30, 1892	1 pig	12,060 cc.	All available quarters.	23 day	Died in **68 days**	**Tuberculosis.** *Serous membranes:* Pleuræ, Pericardium, Peritoneum, } normal. *Organs.*—Lungs. The greater part of the left lung was collapsed. On opening up the bronchi it was seen that the bronchioles were plugged with masses of strongylus filaria. In the right lung, which was not collapsed, were several of these worms. Liver showed a few small white nodules the size of a pin's head. All other organs were normal. *Lymph glands.—Mesenteric;* four of them showed commencing tubercle. All other lymph glands were quite normal. *Intestines.*—The small gut was normal. In the large gut was an enlarged or hardened solitary gland, slightly pigmented, and showing two small points of caseation. *Microscopical Examination.* — *Mesenteric gland,* 11 sections. Caseous tubercle and T. B. xx.

COW 24.

INOCULATION EXPERIMENTS.

Date.	Number of Animals.	Where Inoculated.	Killed in or Died in.	Post-mortem Examination.
Oct. 13, 1891	2 guinea-pigs	2 cc. subcutaneously in right groin from all quarters.	A. died in **1 hour**	A.—The injection had been made into the peritoneal cavity, and there was hæmorrhage into the pericardium.
			B. died in **18 days**	**Tuberculosis.** B.—Lungs showed broncho-pneumonia with collapse. All organs, lymphatic glands, and intestines were quite normal. At the seat of inoculation was an extensive ecchymosis. Beneath this in the connective tissue of the groin was a yellow mottled thickened area extending for a short way on to the abdominal wall. On section this area had a caseous appearance. *Microscopical Examination.—Local lesion,* an inflammatory thickening of connective tissue and muscle. Some collections of necrosing cells. T.B. xx.
Oct. 13, 1891	1 rabbit	5 cc. subcutaneously in each groin from all quarters.	Died in **84 days**	**Tuberculosis.** There were two *caseous glands* at the seat of inoculation, on the right side, and on the left side there was a chain of caseous glands from the knee along the course of the femoral vessels to Poupart's ligament and connected with the enlarged and caseous *pelvic glands.* The *cœliac* and *bronchial* glands were caseous. Other glands normal. The *lungs* were studded throughout with caseous tubercle, discrete and confluent. *Liver* was enlarged and showed two or three irregular areas of caseation. The *spleen* was enlarged and pale and studded with numerous deposits of tubercle. Projecting from the cortex of both *kidneys* were numerous tubercular nodules, some of which were caseating. The heart showed one or two deposits of tubercle along the vessels in the anterior interventricular groove. Other organs were normal. *Microscopical Examination. — Local lesion,* 12 sections. Caseous tubercle. T.B. xxxx.

FEEDING EXPERIMENTS.

Date of Experiment.	Number of Animals.	Quantity taken.	Milk from.	Duration of Feeding.	Killed in or Died in.	Post-mortem Examination.
Oct. 13, 1891	4 guinea-pigs.	1,380 cc.	All quarters of the udder.	6 days	A. died in **17 days** B. died in **17 days**	A. B. Both animals died of inflammation of the lungs. All other organs and all lymph glands and the intestines were quite normal.
					C. died in **22 days**	C.—Lungs showed numerous patches of broncho-pneumonia. All other organs were normal. The cæcal glands were enlarged but not tubercular. Other lymph glands normal. *Small intestine* showed about 2 inches from the ileo-cæcal valve a nodule in the mucous membrane about 1 mm. in diameter. All the Peyer's patches were normal. In the cæcum all the Peyer's patches were enlarged, thickened, and yellowish. At the junction of the cæcum with the colon were two small infiltrated areas with minute yellow caseous-looking foci. Colon and rectum normal. *Microscopical Examinations.—Small intestine.* 21sections. No tubercle bacilli. Not tubercular. *Cæcum.*—74 sections. No tubercle bacilli. Not tubercular.
					D. died in **68 days**	D.—Lungs are affected with pneumonia. There was no tubercle in any of the organs lymph glands, or intestines.

COW 21.

INOCULATION EXPERIMENTS.

Date of Experiment.	Number of Animals.	Material used.	Killed in or Died in.	Post-mortem Examination.
Dec. 9, 1891	1 guinea-pig	Milk from all quarters. 0·3 cc. in right groin.	Died in **63 days**	**Tuberculosis.** There was a *caseous mass* the size of a shilling at the seat of inoculation. The right *inguinal* glands were enlarged and caseous, and the *lumbar, cœliac, bronchial,* and *mediastinal* glands were enlarged and hardened but not caseous. Two of the anterior cervical glands were also enlarged. The *mesenteric glands* were caseous. The *liver* was greatly enlarged, and the tissue was almost completely replaced by grey tubercular masses. *Spleen* was enormously enlarged, and very little splenic tissue remained, it consisting almost entirely of tubercle. *Lungs* contained several minute tubercles the size of a pin's head. Kidneys, suprarenals, brain and its meninges, and the intestines, were normal. *Microscopical Examination.—Mesenteric gland,* 12 sections. Showed caseous tubercle. T.B. xxx.
Jan. 23, 1892	2 guinea-pigs	Milk from all quarters. A. 1 cc. in right groin. B. 1 cc. in each groin.	A. died in **5 days**	A.—At the seat of inoculation was a *caseous mass* surrounded by hard connective tissue. All organs and lymph glands were normal. *Microscopical Examination.*— Cover-slip preparations of caseous material showed no tubercle bacilli. *Local lesion.*—26 sections. Inflammatory thickening and necrosis. No tubercle bacilli. Not tubercular.
			B. died in **36 days**	**Tuberculosis.** B.—On the right side at the seat of inoculation was a *caseous mass,* and on the left side a large ulcer. Both *inguinal* and both *lumbar glands* and the *cœliac glands* were enlarged and caseous on section. The *bronchial glands* showed commencing tubercle. Mesenteric, anterior mediastinal, and cervical glands were normal. *Liver* and *spleen* enlarged and showed nodules of tubercle. *Lungs* showed patches of pneumonia at both bases and numerous miliary tubercles were to be seen beneath the pleura. *Gall bladder* was also affected with tubercle. All other organs were normal. *Microscopical Examination. — Inguinal gland,* 9 sections. Caseous tubercle. T.B. xx.

FEEDING EXPERIMENTS.

Date of Experiment.	Number of Animals.	Quantity taken.	Milk from.	Duration of Feeding.	Killed in or Died in.	Post-mortem Examination.
Dec. 9, 1891	4 guinea-pigs.	200 cc. - -	All quarters of the udder.	2 days -	A. died in **25 days** -	A.—There was no tubercle in any of the organs, lymph glands, or intestines.
					B. died in **48 days** -	**Tuberculosis.** B.—There were some patches of broncho-pneumonia in both lungs. All other organs were normal. The *mesenteric glands* were greatly enlarged and caseous. All other lymph glands were normal. In the *small intestine* were nine tubercular deposits, two of them having ulcerated. Rest of intestines were normal. *Microscopical Examination.* — *Mesenteric gland*, nine sections showed caseous tubercle. T.B. x.
					C. died in **53 days** -	**Tuberculosis.** C.—None of the organs were affected with tubercle. *Mesenteric glands* enlarged and caseous. All other lymph glands normal. In the *small intestine* were four tubercular foci. One of these was an ulcer which formed a complete ring inside the gut. Cæcum and large gut normal. *Microscopical Examination.* — *Mesenteric gland*, nine sections showed advanced caseous tubercle. T.B. x.
					D. died in **67 days** -	**Tuberculosis.** D.—Lungs showed a few small nodules beneath the pleura. Other organs were not affected with tubercle. Mesenteric glands enlarged and caseous. Other lymph glands normal. The intestinal tract showed no tubercular deposit in any part. *Microscopical Examination.* — *Mesenteric gland*, nine sections. Advanced caseous tubercle. T.B. xx.
Dec. 9, 1891	3 guinea-pigs.	10 cc. to which was added 190 cc. of sterile milk.	All quarters	2 days -	A. died in **24 days** -	A.—Lungs pneumonic. Liver showed a few white nodules on its surface. The other organs, all lymph glands, and the intestines, were normal. *Microscopical Examination.—Liver*, 18 sections. Some small areas of degeneration of liver cells. No tubercular structure. No tubercle bacilli.
					B. died in **26 days** -	B. } There was no tubercle in any of the organs, lymph glands, or intestines.
					C. died in **27 days** -	C.
Jan. 23, 1892	4 guinea-pigs.	500 cc. - -	All quarters	5 days -	A. died in **5 days** -	A.—There was no tubercle in any of the organs lymph glands, or intestines.
					B. died in **8 days** -	B.—Lungs pneumonic. There was a small encapsuled body in the spleen, and also in the liver. Other organs, lymph glands, and intestines were normal. *Microscopical Examination.—Liver*, 18 sections. Areas of necrosis of liver cells. Small round-celled infiltration. No tubercle bacilli. A bacterial necrosis.
					C. died in **8 days** -	C. } The cause of death in both animals was pneumonia. There was no tubercle in any of the organs, lymph glands, or intestines.
					D. died in **8 days** -	D.

COW 20.

INOCULATION EXPERIMENTS.

Date of Experiment.	Number of Animals.	Material used.	Killed in or Died in.	Post-mortem Examination.
July 31, 1891 -	1 guinea-pig - -	Milk from all quarters. 2 cc. intra-peritoneally.	Died in **14 days** -	**Tuberculosis.** Double pleural effusion. Acute peritonitis with effusion. Great omentum very large, and cover-slip preparations of the cut surface showed tubercle bacilli. The abdominal wall at the seat of puncture was thickened and showed miliary tubercle. Nil elsewhere.
July 31, 1891	1 guinea-pig - -	Milk from all quarters. 0·5 cc. diluted with 1·5 cc. of sterile milk subcutaneously.	Died in **18 days** -	**Tuberculosis.** There was a large tubercular mass at the seat of inoculation. The great omentum was greatly thickened and tubercular. There was recent peritonitis with miliary granulations over the peritoneum. Some tubercles were present in the spleen, and there were also a few on the surface of the liver. Lungs and other organs normal. *Microscopical Examination.*—Cover-slip preparations of the cut surface of the great omentum showed numerous tubercle bacilli.

FEEDING EXPERIMENTS.

Date of Experiment.	Number of Animals.	Quantity taken.	Milk from.	Duration of Feeding.	Killed in or Died in.	Post-mortem Examination.
July 31, 1891	4 guinea-pigs.	610 cc.	All quarters of the udder.	6 days	A. died in **19 days**	**Tuberculosis.** A.—All organs and lymph glands were quite normal. Beyond the pylorus was some superficial ulceration. The *small intestine* showed two Peyer's patches containing a few white nodules the size of a pin's head. One lymphoid patch in the large intestine showed some white nodules, and there was a series of eight of these nodules arranged along the ridges in the ascending colon. *Microscopical Examination.—Small intestine* showed caseating tubercular nodules. T.B. xxx.
					B. died in **21 days**	**Tuberculosis.** B.—All organs and lymph glands were normal. In the *small intestine* five Peyer's patches showed seven miliary tubercles, caseating with a congested border. One Peyer's patch in the *cæcum* showed two miliary tubercles, and there were a few tubercles in the mucous coat. *Microscopical Examination.—Small intestine* showed caseating tubercular nodules. T.B. xxx.
					C. died in **21 days**	**Tuberculosis.** C.—This animal showed exactly the same post-mortem appearances as Guinea-pig B. *Microscopical Examination.—Small intestine* showed caseating tubercle. T.B. xxx.
					D. died in **39 days**	**Tuberculosis.** D.—*Lungs* showed two miliary tubercles. *Liver* showed 10–15 yellow masses of tubercle, and the *spleen* was affected with numerous tubercular granulations. Other organs were normal. The *bronchial, mesentĕric,* and *cæcal* glands were enlarged and showed caseating tubercle. The *intestines* showed one ulcer near the pylorus. There were 13 ulcers in the rest of the gut, chiefly in the Peyer's patches, all of which were enlarged and showed miliary tubercle, and there were 9–10 miliary tubercles in the mucous membrane. The cæcum showed all Peyer's patches to be ulcerated and numerous miliary tubercles in the mucous membrane, and there were several small ulcers along the ridges of the colon. *Microscopical Examination.—Small intestine* showed an ulcer with tubercular structure. T.B. xx.
July 31, 1891	4 guinea-pigs.	208 cc. to which 660 cc. of sterile milk had been added.	All quarters	4 days	A. died in **12 days**	A.—Lungs showed pneumonia. There was no tubercle in any of the organs, lymph glands or intestines.
					B. died in **19 days**	**Tuberculosis.** B.—Lungs showed broncho-pneumonia and collapse. All other organs and all lymph glands were normal. There were two tubercles with a caseous centre in a *Peyer's patch* in the lower ileum and also one minute white module near a Peyer's patch in the jejunum. Cæcum and large intestine normal. *Microscopical Examination,—Small intestine,* caseous tubercle. T.B. xxx.
					C. died in **37 days**	**Tuberculosis.** C.—*Lungs* showed one nodule of tubercle in each lung. *Liver* showed nine small miliary granulations, and the *spleen* was extensively affected in the same way. All other organs were normal. The *bronchial, mesenteric,* and *cæcal* glands were enlarged and showed caseous areas on section. Other lymph glands were normal. *Intestines*:—There were 20 tubercular ulcers in the small intestine, mostly in the Peyer's patches, which were surrounded by miliary granulations. All the Peyer's patches in the cæcum were tubercular, and two or three of them were ulcerated. There were numerous miliary tubercles between the patches and also in the mucous membrane of the colon, chiefly along the ridges. The rectum was normal. *Microscopical Examination.—Bronchial gland,* 10 sections, caseous tubercle. T.B. xxx.
					D. died in **50 days**	**Tuberculosis.** D.—The *lungs* contained several tubercular nodules. *Liver* showed several scattered tubercular masses on the surface. The *spleen* was slightly enlarged and contained numerous minute tubercles. All other organs were normal. The *bronchial, mediastinal, cæcal,* and *mesenteric glands* were enlarged and caseous on section. The *small intestine* contained 10 tubercular ulcers, mostly in the Peyer's patches, and there were numerous nodules of tubercle scattered throughout the mucous membrane of the gut. The half of the *cæcum* nearest the large gut was one mass of tubercular ulcers and nodules, and there were several tubercular nodules along the ridges of the colon. The rest of the intestine and the other lymph glands were normal. *Microscopical Examination.—Lung,* 10 sections, caseous miliary tubercle. T.B. xx.

COW 25.

INOCULATION EXPERIMENTS.

Date of Experiment.	Number of Animals.	Where Inoculated.	Milk from.	Killed in or Died in.	Post-mortem Examination.
Jan. 20, 1893	1 guinea-pig.	1 cc. Intra-peritoneally.	All four quarters.	Killed in **14 days**	**Tuberculosis.** There was caseation along the track of the needle. The mesentery, omentum, and peritoneal surface of the diaphragm were affected with tubercle. The liver and spleen also showed tubercle. The anterior mediastinal glands were enlarged and caseous and pressed on the veins at the root of the neck. There was an effusion of fluid into both pleuræ. The cœliac and lumbar glands were enlarged, but were not caseous. The cervical and all other lymphatic glands were normal and the lungs and other organs were normal. *Microscopical Examination.*—Two cover-glass preparations were made from the fluid from the cut omentum. Numerous tubercle bacilli.
Mar. 3, 1893	1 guinea-pig.	1 cc. milk subcutaneously in the right groin.	All four quarters.	Killed in **39 days**	**Tuberculosis.** At the seat of inoculation was a large mass of caseous glands. The right lumbar glands were enlarged and caseous, as were also the cœliac glands and the glands in the lesser omentum. The posterior mediastinal and bronchial glands were enlarged and showed one or two small foci of caseation. All other lymph glands were normal. The liver was normal except for an arborescent yellowish area on its surface of a doubtful nature. The spleen was enlarged and showed numerous nodules of tubercle projecting from its surface, and the lungs contained some sparsely scattered miliary tubercles. There was no tubercle in any other organs. *Microscopic Examination.*—Two cover-glass preparations were made of the caseous matter from the glands at the seat of inoculation; showed several tubercle bacilii, singly and in pairs.
Jan. 20, 1893	1 guinea-pig.	1 cc. Intra-peritoneally.	Left posterior quarter.	Killed in **14 days**	**Tuberculosis.** There was caseation and thickening of the tissues along the track of the needle. The mesentery, omentum, and peritoneal surface of the diaphragm showed tubercle. The spleen and liver were also affected with caseous nodules surrounded by congestion. The lung showed nodules of tubercle beneath the pleura. There was also some pleuritic effusion. The lumbar, pyloric, and anterior mediastinal glands were enlarged and caseous. The cœliac, posterior mediastinal, and posterior cervical glands were enlarged but not caseous. Nil elsewhere. *Microscopical Examination.—Great omentum*; 17 sections showed miliary tubercle. T.B. xx.
Feb. 4, 1893	1 guinea-pig.	1 cc. Intra-peritoneally.	Left posterior quarter.	Died in **16 days**	**Tuberculosis.** Lungs showed pneumonia. At the seat of inoculation was a small caseous nodule. The omentum was one mass of tubercle and the peritoneum, especially the under surface of the diaphragm and the mesentery, was studded with minute tubercles. The liver and spleen were also affected with tubercle. The anterior mediastinal glands and the lumbar and cœliac glands were enlarged and caseous, while the bronchial, posterior mediastinal, and cervical glands were enlarged but not caseous. All other organs and lymph glands were normal. *Microscopical Examination.*—Six cover-glass preparations were made of the fluid from the cut omentum. Numerous tubercle bacilli.
Feb. 4, 1893	1 guinea-pig.	1 cc. Intra-peritoneally.	Right posterior quarter.	Died in **19 days**	**Tuberculosis.** Lungs showed pneumonia. There were numerous miliary tubercles scattered over the parietal and visceral peritoneum, and the omentum was greatly thickened. The liver, spleen, and the capsule of the left kidney showed several nodules of tubercle. The cœliac, lumbar, and anterior mediastinal glands, and the glands in the lesser omentum were enlarged and showed commencing caseation. There was no tubercle in any of the other organs or lymph glands. *Microscopical Examination.*—Four cover-glass preparations were made of the juice from the cut surface of the omentum. T.B. xx.
Feb. 4, 1893	1 guinea-pig.	1 cc. Intra-peritoneally.	Left anterior quarter.	Died in **23 days**	**Tuberculosis.** Lungs were collapsed and the pleuræ contained fluid. The peritoneum was thickened at the seat of inoculation. There were some nodules of tubercle in the mesentery, and the omentum was markedly tubercular. The liver and spleen were tubercular. The lumbar, cœliac, and anterior mediastinal glands were enlarged and caseous and the bronchial and posterior mediastinal were enlarged but not caseous. There was no tubercle in any of the other organs or lymph glands. *Microscopical Examination.*—Four cover-glass preparations of the juice from the cut omentum. T.B. xx.
Feb. 4, 1893	1 guinea-pig.	1 cc. Intra-peritoneally.	Right anterior quarter.	Died in **5 days**	Lungs showed pneumonia. There was nothing to be seen at the seat of inoculation and there was no excess of fluid or any unabsorbed milk in the peritoneum. There was no tubercle or other evident disease in the rest of the organs, or in the serous membranes or lymph glands.
Mar. 4, 1893	2 guinea-pigs.	1 cc. each Intra-peritoneally.	A 10 per cent. dilution of the milk from all four quarters.	A. died in **16 days**	**Tuberculosis.** A.—Lungs showed slight broncho-pneumonia. The omentum and spleen showed several nodules of tubercle, the mesenteric glands were caseous, and there were several nodules of tubercle around them, but the peritoneum as a whole was only slightly affected with tubercle. There was no tubercle in any other organs or lymph glands. *Microscopical Examination.*—Two cover-glass preparations of the cut surface of the omentum showed T.B. xx.
				B. died in **18 days**	**Tuberculosis.** B.—There was a small nodule of tubercle at the seat of inoculation. The omentum, spleen, cœliac, and anterior mediastinal glands were tubercular. The liver showed commencing tubercle. There was no tubercle or other evident disease in any other organs, lymph glands or serous membrane. *Microscopical Examination.*—Four cover-glass preparations of the cut surface of the omentum showed T.B. xx.

Date of Experiment.	Number of Animals.	Where Inoculated.	Milk from.	Killed in or Died in.	Post-mortem Examination.
Mar. 4, 1893 -	2 guinea-pigs.	1 cc. each Intra-peritoneally.	A 5 per cent. dilution of the milk from all four quarters.	A. died in **18 days** -	**Tuberculosis.** A.—The track of the needle, the cœliac and anterior mediastinal glands were caseous. The spleen, omentum, and the under surface of the diaphragm were also affected with tubercle. There was no tubercle or other evident disease in the rest of the organs, or in the lymph glands or serous membranes. *Microscopical Examination.*—Two cover-glass preparations of the cut surface of the omentum showed T.B. xxx.
				B. died in **20 days** -	**Tuberculosis.** B.—There was nothing to be seen in the track of the needle. The omentum, liver, and spleen were affected with tubercle, and the cœliac and anterior mediastinal glands were enlarged and caseous. There was no tubercle or other evident disease in the rest of the organs, or in the lymph glands or serous membranes. *Microscopical Examination.*—Four cover-glass preparations were made of the caseous material from the cœliac glands. Numerous tubercle bacilli.
Jan. 31, 1893 -	1 guinea-pig.	1 cc. Intra-peritoneally.	Butter melted at 40° C.	Died in **27 days** -	**Tuberculosis.** At the seat of inoculation was a tubercular nodule, and there were similar nodules on the peritoneum. The omentum, mesentery, liver, and spleen were tubercular, and the mesenteric, cœliac, lumbar, and anterior mediastinal glands were enlarged and caseous. The posterior mediastinal glands were enlarged, but were not caseous. All other glands and organs were normal. *Microscopical Examination.*—Four cover-glass preparations of fluid from the cut omentum showed T.B. xx.
Jan 31, 1893 -	1 guinea-pig.	1 cc. Intra-peritoneally.	Buttermilk	Died in **27 days** -	**Tuberculosis.** At the seat of inoculation was a caseous mass and around this were a few nodules of tubercle. The under surface of the diaphragm, the parietal peritoneum, and the omentum and mesentery were affected with tubercle. The lumbar, cœliac, inguinal, mesenteric, and anterior mediastinal glands, and a gland in the left axilla were enlarged and caseous; as was also a superficial gland at the symphysis of the jaw. The posterior mediastinal and bronchial glands were enlarged, but were not caseous. The liver, spleen, and lungs were affected with tubercle. Nil elsewhere. *Microscopical Examination.*—Four cover-glass preparations of fluid from the cut omentum showed T.B. xx.
Jan. 31, 1893 -	1 guinea-pig.	1 cc. Intra-peritoneally.	Skimmed milk	Died in **29 days** -	**Tuberculosis.** The peritoneum was covered with a large number of tubercles, for the most part caseous. The seat of inoculation was caseous. The mesentery, omentum, liver, and spleen, were extensively affected with tubercle. The lumbar, inguinal, cœliac, and mesenteric glands, and the glands in the anterior mediastinum and the lesser omentum were caseous. The bronchial and posterior mediastinal glands were enlarged, but were not caseous. There was no tubercle or other evident disease in the rest of the organs and lymphatic glands. *Microscopical Examination.*—Four cover-glass preparations of fluid from the cut omentum showed numerous tubercle bacilli.
Jan. 31, 1893 -	1 guinea-pig.	1 cc. Intra-peritoneally.	Milk from the normal cow, whose milk was used in mixing with that of Cow 25 in the manufacture of butter.	Killed in **30 days** -	There was nothing to be seen at the seat of inoculation, and there was no tubercle or other evident disease in any of the organs, serous membranes, or lymph glands.

FEEDING EXPERIMENTS.

Date of Experiment.	Number of Animals.	Quantity taken.	Milk from.	Duration of Feeding.	Killed in or Died in.	Post-mortem Examination.
Jan. 20, 1893	4 guinea-pigs.	300 cc. - -	All four quarters	3 days -	A. died in **3 days** -	A.—Lungs were extensively affected with pneumonia. There was no tubercle or other evident disease in any other organs, or in the lymph glands or intestines.
					B. died in **6 days** -	B.—Lungs showed slight broncho-pneumonia. There was no tubercle or other evident disease in any other organs, or in the lymph glands or intestines.
					C. died in **13 days** -	C.—Lungs were extensively affected with broncho-pneumonia. There was no tubercle or other evident disease in any other organs, or in the lymph glands or intestines
					D. died in **59 days** -	**Tuberculosis.** D.—Lungs showed a few nodules of scattered tubercle as well as some pneumonia. The liver showed large areas of tubercle both in its substance and on the surface. The spleen was enlarged and showed numerous tubercular nodules. The mesenteric, cæcal, lumbar, cœliac, bronchial, anterior and posterior mediastinal glands, and the glands in lesser omentum and at the angle of the jaw were enlarged and caseous, as was also the thymus. The small intestines showed two nodules of tubercle, in Peyer's patches, both in the jejunum. The cæcum showed numerous nodules of tubercle in the Peyer's patches, which were not ulcerated. The colon along its whole length, showed numerous nodules of tubercle, many of which were ulcerated. These nodules were present along the ridges, in the mucous membrane, and in the solitary glands. Nil elsewhere. *Microscopical Examination.*—Two cover-glass preparations were made of the caseous material from the *lumbar glands*; showed T.B. x.

Date of Experiment.	Number of Animals.	Quantity taken.	Milk from.	Duration of Feeding.	Killed in or Died in.	Post-mortem Examination.
Jan. 24. 1893	1 rabbit	600 cc. -	All four quarters of the udder.	6 days -	Killed in **57 days** -	**Tuberculosis.** The animal was very well nourished. The liver showed a small yellowish area of a doubtful nature. The mesenteric glands were enlarged and caseous. The small intestine showed four nodules of tubercle in the mucous membrane of the ileum. There was no tubercle or other evident disease in the rest of the organs, lymph glands, or intestines. *Microscopical Examination.*—Four cover-glass preparations were made of the caseous material from the mesenteric glands showed T.B. x.
Jan. 20, 1893	4 guinea-pigs.	300 cc. - -	All four quarters	3 days -	A. died in **8 days** -	A.—Lungs showed broncho-pneumonia. There was no tubercle or other evident disease in any other organs, or in the lymph glands or intestines.
					B. died in **10 days** -	B.—Liver showed white areas. There was no tubercle or other evident disease in any other organ, or in the lymph glands or intestines. *Microscopical Examination.—Liver,* 10 sections, small-celled infiltration, no caseation, no tubercle bacilli.
					C. died in **13 days** -	C.—Lungs showed slight broncho-pneumonia. There was no tubercle or other evident disease in any other organs, or in the lymph glands or intestines.
					D. died in **13 days**	D.—There was no tubercle or other evident disease in any of the organs, lymph glands, or intestines.
Feb. 3, 1893 -	4 guinea-pigs.	500 cc. - -	All four quarters	days -	A. died in **10 days** -	A.—Lungs showed extensive broncho-pneumonia. There was no tubercle or other evident disease in the other organs, or in the lymph glands or intestines.
					B. died in **35 days**	**Tuberculosis.** B.—The liver and spleen showed commencing tubercle. The mesenteric, cæcal, and cœliac glands were all tubercular. The last Peyer's patch in the small intestine showed several tubercular nodules, as did also three Peyer's patches in the cæcum. The mucous membrane of the cæcum also contained several tubercular nodules, especially around the ilio-cæcal valve. There was no tubercle or other evident disease in the rest of the organs, lymph glands, or intestines. *Microscopical Examination.*—Five cover-glass preparations of caseous material from a *mesenteric gland* showed T.B. x.
					C. died in **45 days** -	**Tuberculosis.** C.—The liver and spleen showed nodules of tubercle. The mesenteric, cæcal, and anterior mediastinal glands showed caseous tubercle. There were 14 small white nodules of tubercle from the pylorus to the ilio-cæcal valve, not situated in the Peyer's patches. The cæcum showed several pigmented and ulcerated Peyer's patches with nodules of tubercle in between them. There was no tubercle or other evident disease in the rest of the organs, lymph glands, or intestines. *Microscopical Examination.*—One cover-glass preparation of caseous material from a *mesenteric gland* showed T.B. xx.
					D. died in **46 days**	**Tuberculosis.** D.—The liver and spleen, and the anterior mediastinal, mesenteric, cæcal, and cœliac glands were affected with tubercle. The small gut showed six white nodules of tubercle, for the most part situated in the mucous membrane of the ileum. The Peyer's patches were not affected. In the cæcum the Peyer's patches were enlarged and hardened, and scattered about in between them were numerous small white tubercular nodules. There was no ulceration. Extending along the ridges of the colon for about 12 inches were several larger tubercular nodules. There was no tubercle or other evident disease in the rest of the organs and lymph glands. *Microscopical Examination.*—Two cover-glass preparations of the caseous material from a *mesenteric gland* showed T.B. xx.
Jan. 31, 1893	1 rabbit	1,000 cc. -	Skimmed milk from all four quarters and from a healthy cow, in equal parts.	5 days -	Killed in **78 days**	**Tuberculosis.** The lungs were extensively affected with miliary tubercle. In the small intestine, about 5 inches from the cæcum, an ulcer about the size of a shilling-piece was situated. There was one yellowish nodule in the jejunum, and there were three similar nodules in the cæcum. The bronchial and mesenteric glands were enlarged and showed commencing caseation. There was no tubercle or other evident disease in any other organ, or in the other lymph glands. *Microscopical Examination.*—One cover-glass preparation of the caseous material from the *mesenteric glands* showed T.B. xxx.
Jan. 31, 1893	1 rabbit	113 grams of butter.	Butter made from the mixed cream from all four quarters and from a healthy cow, in equal parts.	6 days -	Died in **21 days** -	The lungs showed pneumonia. There was no tubercle or other evident disease in any other organs, or in the lymph glands or intestines.

3.—EXPERIMENTS WITH THE MILK OF TWO COWS, THE SUBJECT OF TUBERCULOSIS OF THE INTERNAL ORGANS, AND WITH NON-TUBERCULOUS DISEASE OF THE UDDER.

COWS Nos. 17, 18.

COW 17.

INOCULATION EXPERIMENTS.

Date of Experiment.	Number of Animals.	Where Inoculated.	Milk from.	Killed in or Died in.	Post-mortem Examination.
Feb. 28, 1893	2 guinea-pigs	1 cc. intra-peritoneally.	Left posterior quarter of the udder.	A. died in **10 days** -	A.—Lungs showed broncho-pneumonia. There was nothing abnormal to be seen at the seat of inoculation. There was no tubercle or other evident disease of any other organs, or of the lymph glands, or serous membranes.
				B. died in **13 days** -	B.—There was a small collection of caseous material at the seat of inoculation, with slight peritonitis around. There was no tubercle or other evident disease of any of the organs or lymph glands. *Microscopical Examination.*—Seven cover-glass preparations were made of the caseous matter at the seat of inoculation, showed degenerated cells and cocci. No tubercle bacilli.
Mar. 1, 1893	2 guinea-pigs	1 cc. intra-peritoneally.	Right anterior quarter.	A. died in **21 days** -	A.—Lungs showed extensive broncho-pneumonia. There was nothing abnormal to be seen at the seat of inoculation, and there was no tubercle or other evident disease of any other organs, or of the lymph glands or serous membranes.
				B. died in **23 days**	B.—Lungs showed slight broncho-pneumonia. There was nothing abnormal to be seen at the seat of inoculation, and there was no tubercle or other evident disease of any other organs, or of the lymph glands, or serous membranes.
Mar. 2, 1893	2 guinea-pigs	1 cc. intra-peritoneally.	Right posterior quarter.	A. died in **22 days**	A.—Lungs showed extensive pneumonia. There was nothing abnormal to be seen at the seat of inoculation, and there was no tubercle or other evident disease of any other organs, or of the lymph glands, or serous membranes.
				B. died in **27 days** -	B.—Lungs showed pneumonia. There was nothing abnormal to be seen at the seat of inoculation, and there was no tubercle or other evident disease of any other organs, or of the lymph glands or serous membranes.
Mar. 2, 1893	2 guinea-pigs	1 cc. intra-peritoneally.	Left anterior quarter.	A. died in **26 days** -	A.—Lungs were affected with broncho-pneumonia. There was nothing abnormal to be seen at the seat of inoculation, and there was no tubercle or other evident disease of any other organs, or of the lymph glands, or serous membranes.
				B. died in **27 days** -	B.—Lungs showed broncho-pneumonia. There was nothing abnormal to be seen at the seat of inoculation, and there was no tubercle or other evident disease of any other organs, or of the lymph glands, or serous membranes.

FEEDING EXPERIMENTS.

Date of Experiment.	Number of Animals.	Quantity taken.	Milk from.	Duration of Feeding.	Killed in or Died in.	Post-mortem Examination.
Mar. 1, 1893 -	4 guinea-pigs.	2,350 cc. - -	All four quarters of the udder.	16 days -	A. died in **17 days** -	A.—Lungs showed broncho-pneumonia. There was no tubercle or other evident disease in any other organs, or in the lymph glands, or intestines.
					B. died in **19 days** -	B.—Lungs showed broncho-pneumonia. There was no tubercle or other evident disease in any other organs, or in the lymph glands, or intestines.
					C. died in **25 days** -	C.—Lungs were extensively affected with broncho-pneumonia. There was no tubercle or other evident disease in any other organs, or in the lymph glands, or intestines.
					D. died in **27 days**	D.—The cause of death was broncho-pneumonia. There was no tubercle or other evident disease in any other organs, or in the lymph glands or intestines.
Mar. 1, 1893 -	4 guinea-pigs.	2,350 cc. - -	All four quarters	16 days -	A. died in **10 days** -	A.—The animal was pregnant. The right horn of the uterus had ruptured and a placenta was loose in the peritoneal cavity. There was no tubercle or other evident disease in any of the organs, lymph glands, or intestines.
					B. died in **26 days** -	B.—Lungs showed extensive broncho-pneumonia. There was no tubercle or other evident disease of any other organs, or of the lymph glands, or intestines.
					C. died in **29 days** -	B.—Lungs showed broncho-pneumonia. There was no tubercle or other evident disease of any other organs, or of the lymph glands, or intestines.
					D. died in **29 days**	C.—Lungs showed pneumonic consolidation at both bases. There was no tubercle or other evident disease in any other organs, or in the lymph glands, or intestines.
Feb. 24, 1893	1 pig - -	111,450 cc. -	All four quarters	23 days -	Killed in **63 days** -	*Serous Membranes* :— Pleuræ, } normal. Pericardium, } normal. Peritoneum. } normal. *Organs.*—Lungs, heart, liver, spleen, kidneys, and suprarenals were all quite normal. Tongue, tonsils, and larynx were normal. *Lymph glands.*—Mesenteric, cervical, mediastinal, bronchial, cœliac, cæcal, and lumbar glands were all quite normal. *Intestines.*—The intestinal tract was normal throughout. There was no tubercle or other disease anywhere.

COW 18.

Inoculation Experiments.

Date of Experiment.	Number of Animals.	Where Inoculated.	Milk from.	Killed in or Died in.	Post-mortem Examination.
Feb. 23, 1893	3 guinea-pigs	1 cc. intra-peritoneally.	All four quarters.	A. died in **10 days** - B. died in **21 days** - C. died in **24 days** -	A.—There was nothing abnormal to be seen at the seat of inoculation, but the peritoneum was slightly congested. There was no tubercle or other evident disease in any of the organs or lymph glands. B.—There was nothing abnormal to be seen at the seat of inoculation. The *omentum* was greatly thickened at one part and caseous looking on section. Lungs showed pneumonia. There was no tubercle or other evident disease in any of the other organs or in the lymph glands. *Microscopical Examination.*—Six cover-glass preparations of the *omentum* showed degenerated cells and cocci. No tubercle bacilli. Bacterial necrosis. C.—There was no tubercle or other evident disease of any of the organs or lymph glands. Nil at seat of inoculation.
Feb. 25, 1893	3 guinea-pigs	1 cc. intra-peritoneally.	All four quarters.	A. died in **20 days** - B. died in **25 days** - C. died in **25 days** -	A.—There were some sub-pleural petechiæ, There was nothing abnormal to be seen at the seat of inoculation. There was no tubercle or other evident disease of any of the organs or lymph glands. B.—Lungs showed extensive broncho-pneumonia. There was nothing abnormal to be seen at the seat of inoculation. There was no tubercle or other evident disease of any other organs, or of the lymph glands. C.—Lungs showed slightbroncho-pneumonia. There was nothing abnormal to be seen at the seat of inoculation. There was no tubercle or other evident disease of any other organs, or of the lymph glands.
Feb. 23, 1893	1 guinea-pig -	1 cc. intra-peritoneally.	Left anterior quarter.	Died in **4 days** -	There was nothing abnormal to be seen at the seat of inoculation, and there was no peritonitis. There was no tubercle or other evident disease in any of the organs or lymph glands.
Feb. 23, 1893	1 guinea-pig -	1 cc. intra-peritoneally.	Right posterior quarter.	Died in **5 days** -	There was nothing abnormal to be seen at the seat of inoculation. Lungs showed broncho-pneumonia. There was no tubercle or other evident disease in any other organs, or in the lymph glands.
Feb. 23, 1893	1 guinea-pig -	1 cc. intra-peritoneally.	Right anterior quarter,	Died in **13 days** -	Liver showed a nodule of parasitic disease. There was a small *caseous mass* about the size of a cherry stone firmly uniting the cæcum and ascending colon together. There was nothing abnormal to be seen at the seat of inoculation, and there was no tubercle or other evident disease of any other organs or of the lymph glands. *Microscopical Examination.*—Six cover-glass preparations of the *caseous mass* showed degenerated cells and numerous cocci. No tubercle bacilli. Bacterial necrosis.
Feb. 23, 1893	2 guinea-pigs	1 cc. intra-peritoneally.	Left posterior quarter.	A. died in **14 days** - B. killed in **54 days**	A.—There was nothing abnormal to be seen at the seat of inoculation, and there was no tubercle or other disease of any of the organs, lymph glands, or serous membranes. B.—There was nothing abnormal to be seen at the seat of inoculation, and there was no tubercle or other evident disease of any of the organs, lymph glands, or serous membranes.

4.—EXPERIMENTS WITH THE MILK OF TWO COWS, WITH NON-TUBERCULAR DISEASE OF THE UDDER, AND NO TUBERCULOSIS OF THE INTERNAL ORGANS.

COWS Nos. 26, 27.

These cows were purchased on the supposition that the disease of the udder was tuberculous.

COW 26.

Inoculation Experiments.

Date of Experiment.	Number of Animals.	Where inoculated.	Milk from.	Killed in or Died in.	Post-mortem Examination.
Dec. 11, 1892	2 guinea-pigs	1 cc. subcutaneously in each right groin.	Right anterior quarter.	A. died in **17 days** B. died in **31 days**	A.—There was nothing abnormal to be seen at the seat of inoculation. Lungs showed broncho-pneumonia. There was no tubercle or other evident disease in any other organ or in the lymph glands. B.—Lungs showed slight broncho-pneumonia. There was no tubercle or other evident disease in any other organ or in the lymph glands, and there was nothing abnormal to be seen at the seat of inoculation.
Dec. 11, 1892	2 guinea-pigs	1 cc. subcutaneously in each right groin.	Left posterior quarter.	A. died in **17 days** B. died in **18 days**	A.—Lungs showed broncho-pneumonia and there were some enlarged glands at the seat of inoculation, which were caseous on section. There was no tubercle or other evident disease in any other organ or lymph gland. *Microscopical Examination.—Local lesion,* 13 sections. Inflammatory thickening and cell-necrosis. Groups of staphylococci. No tubercle bacilli. Bacterial necrosis. B.—Lungs showed broncho-pneumonia, and there were some enlarged glands present at the seat of inoculation, which were caseous on section. There was no tubercle or other evident disease in any other organ or lymph gland. *Microscopical Examination.—Local lesion,* 13 sections. Inflammatory thickening and cell-necrosis. No tubercle bacilli. Not tubercular.
Dec. 12, 1892	1 rabbit -	5 cc. subcutaneously in each groin.	All four quarters.	Killed in **56 days**	The animal was very fat and well nourished. There was a parasitic cyst attached to the peritoneal covering of the liver. There was no tubercle or other evident disease in any of the organs or lymph glands, and there was nothing abnormal to be seen at either seat of inoculation.
Dec. 18, 1892	2 guinea-pigs	1 cc. subcutaneously in each right groin.	Left anterior quarter.	A. died in **[illegible]3 days** B. died in **18 days**	A. B. The cause of death in both animals was broncho-pneumonia. There was nothing abnormal to be seen at either of the seats of inoculation, and there was no tubercle or other evident disease in any other organs or in the lymph glands.
Jan. 18, 1893	1 guinea-pig -	1 cc. intra-peritoneally.	Left anterior quarter.	Killed in **36 days**	Well nourished. All organs and lymph glands normal.

FEEDING EXPERIMENTS.

Date of Experiment.	Number of Animals.	Quantity taken.	Milk from.	Duration of Feeding.	Killed in or Died in.	Post-mortem Examination.
Dec. 13, 1892	1 rabbit -	500 cc. - -	Right anterior quarter.	5 days -	Killed in **63 days** -	The animal was very well nourished. There were some parasitic cysts attached to the omentum. There was no tubercle or other evident disease in any of the organs, lymph glands, or intestines.
Dec. 13, 1892	1 rabbit -	500 cc. - -	Right posterior quarter.	5 days -	Killed in **55 days** -	The animal was very fat and well nourished. There were two parasitic cysts attached to the great omentum. There was no tubercle or other evident disease in any of the organs, lymph glands, or intestines.
*Jan. 10, 1893	1 pig - -	12,900 cc. -	Skimmed milk from all four quarters.	4 days -	Died in **68 days** -	**Tuberculosis.** An abscess behind the angle of the right jaw was noticed 25 days after feeding. *Serous membranes.—Pleuræ.* Pleurisy with effusion on both sides. *Pericardium.*—Nil. *Peritoneum.*—Numerous small white nodules of tubercles were present in the omentum and covering some of the intestines, especially the large. *Organs.—Lungs* were studded with miliary tubercules throughout. *Liver*, studded with several nodules of tubercle, none larger than a pea. Only a few of the larger ones were caseating. *Spleen.*—There were numerous large nodules of caseating tubercle, coalescing with one another, and there were adhesions between the capsule of the spleen and the parietal peritonium. All other organs were quite normal. *Tonsils.*—On the right tonsil was a circumscribed clean-cut ulcer about the size of a shilling. *Lymph glands.*—Extending down from the angle of the jaw on the right side to the right axilla was a chain of hard enlarged and caseating glands. At the angle of the jaw two or three glands were matted together, and an abscess had formed which was noticed during life. The glands behind the sternum were enlarged and caseous on section, as were also the bronchial, posterior mediastinal, mesenteric (all), glands in the lesser omentum, and cœliac glands. *Intestines.*—Were quite normal except the cæcum, which showed numerous tuberculous ulcers the size of a shilling to a two-shilling piece. *Microscopical Examination.—Liver*, 12 sections. Miliary tubercle, giant cells, no tubercle bacilli found. *Lung.*—12 sections. Caseous miliary tubercle, T.B. x. *Cervical gland.*—12 sections, caseous tubercle, T.B. x.
Dec. 25, 1892	1 pig -	13,455 cc. -	All four quarters	7 days -	Killed in **103 days**	*Serous membranes*:— Pleuræ, Pericardium, Peritoneum, } normal. *Organs.*—Lungs, heart, liver, spleen, kidneys, suprarenals, uterus, and ovaries were quite normal. *Lymph glands.* — Mediastinal, bronchial, cœliac, lumbar, cervical, and mesenteric glands, and the glands in the lesser omentum were normal. The tongue and tonsils were normal. *Intestines.*—The intestinal tract was normal throughout.
Jan. 11, 1893	1 pig - -	312 grams of butter.	Butter made from the milk of all four quarters.	3 days -	Killed in **86 days**	*Serous membranes*:— Pleuræ, Pericardium, Peritoneum, } normal. *Organs.*—Lungs, heart, liver, spleen, kidneys, and suprarenals, were all quite normal. *Lymph glands.*—Mediastinal, mesenteric, bronchial, cœliac, cervical, and lumbar glands, and the glands in the lesser omentum were all normal. The tongue and tonsils were normal. *Intestines.*—The intestinal tract was normal throughout.

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* For the explanation of the occurrence of this case of tuberculosis, see Part I., page 12.

COW 27.

INOCULATION EXPERIMENTS.

Date of Experiment.	Number of Animals.	Where inoculated.	Milk from.	Killed in or Died in.	Post-mortem Examination.
Jan. 18, 1893	1 guinea-pig.	1 cc. intra-peritoneally.	Right posterior quarter of the udder.	Killed in **16 days** -	In the abdominal wall was a small hard mass, not caseating, and not communicating with the abdominal cavity, from which it was shut off by a thickening of the peritoneum. There was some slight enlargement of the lymphatic glands in the neighbourhood. *Microscopical Examination.—Local Lesion.*—Thirteen sections. Inflammatory thickening of connective tissue. No caseation. No tubercle bacilli. *Lymph gland.*—Fifteen sections. Inflammatory hyperplasia of gland tissue. No caseation. No tubercle bacilli.
Jan. 18, 1893	1 guinea-pig.	1 cc. sub-cutaneously in tissues of the abdominal wall.	Right anterior quarter.	Killed in **16 days** -	There was a fluctuating swelling on the abdominal wall, which consisted of an abscess cavity with caseous contents. Several enlarged and hardened glands were found in the neighbourhood of the abscess, but they were not caseous. There was no tubercle or other evident disease in any other lymph glands or in the organs. *Microscopical Examination.—Gland.*—Twelve sections. Inflammatory hyperplasia of gland tissue and connective tissue around. No caseation. No tubercle bacilli. Four cover-glass preparations were made of the abscess contents. No tubercle bacilli; but rapidly necrosing cells and streptococci were found.
Jan. 18, 1893	1 guinea-pig.	1 cc. intra-peritoneally.	Left anterior quarter.	Died in **7 days** -	The peritoneum was full of a semi-purulent blood-stained fluid with flakes of lymph floating about in it. The omentum was a good deal injected, but there was no tubercle. There was nothing to be seen of the puncture. There was no tubercle or other evident disease in any of the organs or lymph glands. *Microscopical Exmaination.*—Six cover-glass preparations were made of the peritoneal fluid. Numerous streptococci, staphylococci, and cells undergoing necrosis. No tubercle bacilli.
Jan. 18, 1893	1 guinea-pig.	1 cc. intra-peritoneally.	Left posterior quarter.	Died in **16 days** -	There was no sign of the puncture in the abdominal wall. There was no tubercle or other evident disease of the peritoneum, organs, or lymph glands.
Feb. 6, 1893	2 guinea-pigs.	1 cc. intra-peritoneally.	Left posterior quarter.	A. Killed in **29 days** B. Killed in **29 days**	A. } B. } There was nothing abnormal to be seen at the seat of inoculation. There was no tubercle or other evident disease in any of the serous membranes, organs, or lymph glands.
Feb. 6, 1893	2 guinea-pigs.	1 cc. intra-peritoneally.	Two anterior and right posterior quarters.	A. Killed in **29 days** B. Killed in **29 days**	A. } B. } There was nothing abnormal to be seen at the seat of inoculation. There was no tubercle or other evident disease in any of the serous membranes, organs, or lymph glands.

FEEDING EXPERIMENTS.

Date of Experiment.	Number of Animals.	Quantity taken.	Milk from.	Duration of Feeding.	Died in or Killed.	Post-mortem Examination.
Jan. 18, 1893	1 guinea-pig.	90 cc. - -	Left posterior quarter of the udder.	1 day -	Killed in **47 days** -	There was no tubercle or other evident disease in any of the organs, lymph glands, or intestines.
Jan. 18, 1893	1 guinea-pig.	90 cc. - -	Two anterior and right posterior quarters.	1 day -	Killed in **47 days** -	There was no tubercle or other evident disease in any of the organs, lymph glands, or intestines.
Jan. 19, 1893	4 guinea-pigs.	2,100 cc. -	Left posterior quarter.	15 days -	A. died in **2 days** B. died in **16 days** - C. died in **42 days** - D. died in **61 days** -	A.—Lungs showed broncho-pneumonia. There was no tubercle or other evident disease of any other organ, or of the lymph glands or intestines. B.—The small intestine and uterus had been eaten by the other guinea-pigs in the cage. The large intestine and remaining organs were quite normal. Two of the mesenteric glands showed three or four yellow points. *Microscopic Examination.—Mesenteric gland,* 17 sections. Inflammatory. Points of suppuration. Numerous streptococci, chiefly in the cells. No tubercle bacilli. Not tubercular. C.—Lungs showed pneumonia at the right base. Jaundice. There was no tubercle or other evident disease in any other organ, or in the lymph glands or intestines. D.—Lungs showed broncho-pneumonia. There was no tubercle or other evident disease of any other organ, or of the lymph glands or intestines.
Jan. 19, 1893	4 guinea-pigs.	2,100 cc. -	Left posterior quarter.	15 days -	A. died in **4 days** - B. died in **34 days** C. died in **59 days** - D. died in **62 days**	A.—Lungs were slightly affected with broncho-pneumonia. There was no tubercle or any other evident disease in any other organ or in the lymph glands or intestines. B.—Lungs showed pneumonia. There was no tubercle or other evident disease in any other organ or in the lymph glands or intestines. C.—Lungs showed slight broncho-pneumonia. There was no tubercle or other evident disease in any other organ or in the lymph glands or intestines. D.—Lungs showed broncho-pneumonia. There was no tubercle or other evident disease in any other organ or in the lymph glands or intestines.

Date of Experiment.	Number of Animals.	Quantity taken.	Milk from.	Duration of Feeding.	Killed in or Died in.	Post-mortem Examination.
Feb. 8, 1893	1 rabbit	1,624 cc. -	Milk from the two anterior and right posterior quarters.	19 days -	Killed in **70 days** -	The animal was very fat and well nourished. There was no tubercle or other evident disease in any of the organs, lymph glands, or intestines.
Jan. 24, 1893	1 pig	39,710 cc. -	Skimmed milk from left posterior quarter	10 days -	Killed in **91 days** -	The animal was well nourished. *Serous Membranes:* Pleuræ, Pericardium, Peritoneum, } were all normal. *Organs.*—Liver, spleen, kidneys, suprarenals, lungs, and all other organs were quite normal. *Lymph Glands.*—Mediastinal, bronchial, cervical, mesenteric, cæcal, cœliac, and lumbar glands, and the glands in the lesser omentum were all quite normal. *Intestines.*—The intestinal tract was normal throughout.
*Jan. 24, 1893	1 pig	910 grams of butter.	Butter made from milk of left posterior quarter.	3 days -	Killed in **91 days** -	**Tuberculosis.** The animal was very well nourished *Serous Membranes:* *Pleuræ.*—On the right pleura were scattered numerous grapes, more especially at the apex and base. Left pleura was normal. *Pericardium,* *Peritoneum,* } normal. *Organs.*—Both *lungs* were affected with miliary tubercle, more especially the right. The right lung showed one, and the left two nodules of tubercle caseating. These nodules were of the size of a 3*d*. piece. *Liver* showed numerous yellowish nodules on its upper surface. All other organs were quite normal. *Tonsils* and tongue were normal. *Lymph Glands.*—The bronchial and the mediastinal glands were enlarged and caseous. No other lymph glands were affected with tubercle or other evident disease. *Intestines.*—The large and small intestines were perfectly normal. *Microscopical Examination.*—Two cover-slip preparations of the bronchial glands showed T.B. x.

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* For the explanation of the occurrence of this case of tuberculosis, see Part I., p. 12.

INQUIRY II.

PART IX.

DETAILS of the EXPERIMENTS of FEEDING GUINEA-PIGS, PIGS, and CALVES with HUMAN and BOVINE TUBERCULOUS MATERIAL. The results of the Experiments are considered in Part I. of the Report, p. 13, *et seq.*

FEEDING EXPERIMENTS in GUINEA-PIGS with HUMAN TUBERCULOUS MATERIAL, Sputum from Cases of Pulmonary Tuberculosis in Man.

Date of Commencement of Experiment.	Number of Animals.	Quantity eaten.	Material used.	Duration of Feeding.	Killed in or Died in.	Post-mortem Examination.
Sept. 3, 1891 -	4 guinea-pigs.	20 cc. - - -	Sputum from phthisical patients, containing numerous tubercle bacilli.	1 day -	A. killed in **14 days**	A.—All organs and lymph glands were normal. One of the Peyer's patches in the small intestine contained a yellow spot. Nothing abnormal elsewhere. *Microscopical Examination:*— *Peyer's patch* (small gut).—24 sections. Normal. No tubercle bacilli. *Peyer's patch* (cæcum).—25 sections. Normal. No tubercle bacilli.
					B. killed in **28 days**	**Tuberculosis.** B.—The *mesenteric glands* showed caseous tubercle, all other lymph glands being normal. There were four deposits of tubercle in the *small intestine,* one of which was ulcerated. Two Peyer's patches in the cæcum appeared to be infiltrated with tubercle. There was nothing abnormal elsewhere. *Microscopical Examination:*— *Mesenteric gland.*—8 sections. Caseous tubercle. T.B. x.
					C. killed in **42 days**	**Tuberculosis.** C.—The *liver* and *spleen* showed patches of caseous tubercle. All other organs were normal. The *mesenteric glands* were caseous, and a *cæcal gland* showed commencing tubercle. Other lymph glands were normal. There were numerous foci of tubercular infiltration in the *ileum.* The rest of the small intestine and the cæcum and colon were normal. There was nothing abnormal elsewhere. *Microscopical Examination:*— *Lung.*—8 sections. Broncho-pneumonia. No tubercle bacilli. *Spleen.*—8 sections. Congestion. Necrosing areas. Giant cells. No tubercle bacilli. *Liver.*—8 sections. Mostly normal liver tissue. Two collections of small round cells. No caseation. No tubercle bacilli. *Cæcal glands.*—13 sections. Caseous tubercle in several foci. No tubercle bacilli. *Mesenteric glands.*—7 sections. Caseous tubercle. T.B. x. *Intestine.*—23 sections. Small celled sub-mucous tubercle. No caseation. No tubercle bacilli.
					D. died in **53 days**	**Tuberculosis.** D.—The *lungs, liver,* and *spleen* showed a few white spots on their surfaces. The *bronchial* and *cæcal* glands were enlarged and caseous. Other lymph glands normal. The *small intestine* was normal throughout, but some Peyer's patches in the *cæcum* were thickened and contained some opaque white spots. The colon was normal, and there was nothing abnormal elsewhere. *Microscopical Examination:*— *Lung.*—7 sections. Miliary tubercle sparsely scattered. Commencing necrosis. T.B., very few. *Liver.*—7 sections. Caseous tubercle. T.B., very few. *Spleen.*—7 sections. Caseous tubercle. T.B., very few. *Peyer's patch* (cæcum).—16 sections. No caseation. No tubercle bacilli. *Cæcal gland.*—12 sections. Normal.

FEEDING EXPERIMENTS in GUINEA-PIGS with BOVINE TUBERCULOUS MATERIAL.

Date of Commencement of Experiment.	Number of Animals.	Quantity eaten.	Material used.	Duration of Feeding.	Killed in or Died in.	Post-mortem Examination.
June 23, 1891	4 guinea-pigs.	Measuring one ounce, water being mixed in about equal parts with the minced material.	“Grapes” from Cow 19.	1 day -	A. died in **12 days** -	A.—All organs and lymph glands were normal. There was an ulcer in the *duodenum*, scrapings from which contained no tubercle bacilli. There were also three small white nodules in the mucous membrane of the intestine.
					B. killed in **59 days**	**Tuberculosis.** B.—The *lungs, liver,* and *spleen* were all affected with caseous tubercle. The *mesenteric, cœliac,* and *cæcal* glands were enlarged and caseous, and contained tubercle bacilli. All the Peyer's patches in the *small intestine* except one were infiltrated with tubercle, and two of the patches were superficially ulcerated. The Peyer's patches in the *cæcum* were enlarged and tubercular, and there were a few tubercles along the ridges of the colon. *Microscopical Examination:*— *Peyer's patch.*—18 sections. Tubercular infiltration. Ulcer on surface. A few small foci of caseation. Tubercle bacilli in very small number.
					C. died in **78 days** -	**Tuberculosis.** C.—The *lungs* and *spleen* showed several nodules of tubercle, and the *liver* several nodules of a doubtful nature. The *mesenteric, cæcal,* and *cœliac* glands showed hard, deeply pigmented tubercle, the other glands being normal. The *small intestine* contained 20 nodules of tubercle, hard, deeply pigmented and 6 to 10 mins. in diameter some few of which were superficially ulcerated. There were also nodules of tubercle in the *cæcum*, and along the ridges of the colon. Other organs and lymph glands normal. *Microscopical Examination:*— *Intestine.*—28 sections. Caseous tubercle. T.B. x.
					D. died in **92 days** -	**Tuberculosis.** D.—The *lungs, liver,* and *spleen* contained numerous tubercles. The *mesenteric, cæcal, cœliac, retro-hepatic, bronchial,* and *posterior mediastinal* glands showed caseous tubercle. The *small intestine* contained 29 tuberculous ulcers. The *cæcum* contained 11 ulcers, and there were several small ones along the ridges of the colon. *Microscopical Examination:*— *Lung.*—6 sections. Caseous tubercle. T.B. xxx.

FEEDING EXPERIMENT in a PIG with BOVINE TUBERCULOUS MATERIAL, tuberculous lung of Cow 13.

Date of Commencement of Experiment.	Number of Animals.	Quantity eaten.	Material used.	Duration of Feeding.	Killed in or Died in.	Post-mortem Examination.
Nov. 11, 1892	1 pig -	120 g. - -	Tuberculous material from the lung of Cow 13.	1 day -	Killed in **57 days** -	**Tuberculosis.** All the *serous membranes* were normal. Both *lungs* were infiltrated throughout with miliary tubercles in size from a pin's head to a split pea, and beginning to caseate. The *liver* showed numerous small white nodules of tubercle on the surface, and a smaller number in its substance. The *spleen* contained numerous caseating tubercular nodules. All the other organs were normal. Three *mesenteric glands* were enlarged and hardened, or showed on section caseating tubercle. Eight others showed small white nodules about the size of a pin's head. A gland in the posterior mediastinum was tuberculous, as well as some of the glands in the lesser omentum. All the other lymph glands were normal. In the middle of the *ileum*, situated in a Peyer's patch, was a small circular ulcer about the size of a threepenny piece, with raised and thickened edges. Just outside the ulcer was a small tubercle. The rest of the *small gut* and the *cæcum, colon,* and *rectum* were quite normal. *Microscopical Examination:*— *Lung.*—9 sections, Miliary tubercle. Commencing caseation. T.B. x. *Mesenteric gland.*—9 sections. Caseating tubercle. T.B. x. *Ulcer of small gut.*—13 sections. There was some small-celled infiltration beneath the ulcer. No caseation. No tubercle bacilli.

Feeding Experiments in Calves with Bovine Tuberculous Material.

Date of Commencement of Experiment.	Number of Animals	Quantity eaten.	Material Used.	Duration of Feeding.	Killed in or Died in	Post-mortem Examination.
Aug. 5, 1891 -	4 calves -	2 lbs. - -	Tubercular udder, lungs and mesenteric gland from Cow 20.	1 day -	A. killed in **28 days**	**Tuberculosis.** A.—*Serous membranes* normal. The *lungs* showed on their surfaces several translucent bodies, the size of a split pea. All the other organs were normal. There was no evident tubercle in any of the lymph glands, but in the cortex of several of the mesenteric glands were some minute yellow points. In the *small intestine* 10 Peyer's patches showed miliary tubercles, and there were some few deposits of tubercle in the mucous membrane of the intestine; 116 nodules of tubercle in all. The *cæcum* and *large gut* were normal, and there was no ulceration anywhere. *Microscopical Examination:—* *Mesenteric glands*—14 sections. Caseous tubercle. T.B. xxx. *Liver.*—16 sections, normal. *Spleen.*—12 sections, normal. *Lung.*—14 sections, fibrosis, giant cells. No caseation. No tubercle bacilli. At the surface of the lung was a caseous nodule. T.B. xx. *Small intestine.*—54 sections of the nodules contained T.B. x. 14 sections contained no tubercle bacilli.
					B. killed in **61 days**	**Tuberculosis.** B.—*Serous membranes* normal. The *lungs* contained seven nodules of tubercle, the smallest the size of a split pea and the largest the size of a bean. The *liver* showed a small yellow area. All other organs were normal. One *mesenteric gland* showed definite caseous tubercle, and the *mediastinal, bronchial,* and *cervical* glands showed several yellow points of a doubtful nature in their cortices. The *larynx and trachea* were normal. There were nine tubercles in the *Peyer's patches,* and one in the mucous membrane of the small intestine. Four of the patches were caseous, but there was no ulceration, The *cæcum and large intestine* was normal throughout. *Microscopical Examination:—* *Various nodules in small gut.*—88 sections normal. No T.B. *Bronchial glands.*—12 sections. Caseous tubercle. T.B. xx. *Mediastinal glands.*—12 sections. Caseous tubercle. T.B. xx. *Lung.*—10 sections. Caseous tubercle. T.B. x.
					C. killed in **85 days**	**Tuberculosis.** C.—There was a considerable deposit of "grapes" on the upper surface of the diaphragm on the visceral and parietal *pleura,* and extending up into the outer surface of the pericardium. The *peritoneum* was normal. The *lungs* contained several nodules of tubercle, for the most part caseous. The right lung was affected more than the left. The *larynx and trachea,* and all the other organs were quite normal. The *mesenteric, cæcal, bronchial, mediastinal and cervical glands* were enlarged and caseous in parts. The last Peyer's patch in the *ileum* showed innumerable foci of tubercle, for the most part superficially ulcerated. The collections of tubercles became fewer towards the duodenum. There were numerous collections of tubercles in the *cæcum,* but none in the *colon.* *Microscopical Examination:—* *Lung.*—10 sections. Caseous tubercle. T.B. x. *Grapes.*—14 sections. Miliary tubercle. T.B. x. *Intestinal ulcer.*—19 sections. Filroid and round-celled tubercle. Giant-cells. T.B. x.
					D. killed in **259 days.**	**Tuberculosis.** D.—There were a large number of "grapes" on the upper surface of the diaphragm, on both layers of the *pleura,* and on the outer surface of the *pericardium,* The right pleura contained about three-quarters of a pint of turbid fluid. The *peritoneum* was normal. The *larynx and trachea* and all organs were quite normal. The *mesenteric glands* were all affected with calcareous tubercle, as were also the superficial *cervical, bronchial, and posterior mediastinal glands.* All other lymph-glands were normal. The *small intestine* contained 25 nodules of tubercle, being most numerous in the ileum. The *cæcum* was normal, and there was no ulceration of the intestine. *Microscopical Examination:—* *Gland in lesser omentum.*—10 sections. Caseous tubercle. T.B. *Cervical gland.*—9 sections. Normal gland tissue. *Posterior mediastinal gland.*—15 sections. Caseous tubercle. Giant cells. No T.B. *Mesenteric gland.*—11 sections. Caseous tubercle. T.B. x. *Peyer's patch.*—48 sections, normal lymphoid tissue. No T.B. No caseation.

FEEDING EXPERIMENT in FOUR CALVES with HUMAN TUBERCULOUS MATERIAL, 70 cc. of Sputum from Cases of Pulmonary Tuberculosis in Man.—EXPERIMENT I.

Date of Commencement of Experiment.	Number of Animals.	Quantity eaten.	Material used.	Duration of Feeding.	Killed in or Died in	Post-mortem Examination.
Sept. 1, 1891 -	4 calves -	70 cc. - -	Sputum from 2 phthisical patients containing numerous tubercle bacilli.	1 day -	A. killed in **33 days**	**Tuberculosis.** A.—*Serous membranes* normal. All organs normal. Two of the *cæcal glands* showed a nodule the size of a split pea, with a yellow caseous centre. All other lymph glands normal. In the *small intestine* were 53 tubercles with caseous centres in the Peyer's patches, and 10 in the mucous membrane. The *cæcum and large intestine* were normal. *Microscopical Examination* :— *Liver.*—13 sections. Normal. *Spleen.*—Nine sections. Normal. *Mesenteric gland.*—14 sections. Normal. *Peyer's patch.*—42 sections. Caseous tubercle and giant cells in 23 sections. Nine sections showed caseous tubercle and no giant cells. None of them showed any tubercle bacilli. Ten sections were normal.
					B. killed in **63 days**	**Tuberculosis.** B.—*Serous membranes* and all organs normal. One of the lymph glands round rumen showed a doubtful nodule, but all the other glands were normal. The *small intestine* showed 51 nodules of tubercle in the Peyer's patches. These were caseous for the most part. There were 12 other nodules in the mucous membrane. The *cæcum and colon* were quite normal. None of the tubercles were ulcerated. *Microscopical Examination* :— *Gland round rumen.*—18 sections. Normal. *Nodule in intestinal mucous membrane.*—25 sections. A normal solitary gland. *Nodule in Peyer's patch.*—32 sections. Caseation in the centre of a nodule of lymphoid tissue. No tubercle bacilli.
					C killed in **85 days**	**Tuberculosis.** C.—The *serous membranes* and all organs were normal. All the *lymph glands* were normal. The *small intestine* showed, in its Peyer's patches, 17 nodules, some of which were of the size of a pea, and distinctly caseated in the centre. The *cæcum and colon* were normal. *Microscopical Examination* :— *Nodule in a Peyer's patch.*—23 sections. Nodule not caseous, surrounded by connective tissue. No tubercle bacilli. *Nodule in a Peyer's patch.*—22 sections. A small caseous nodule surrounded by young connective tissue and giant cells T.B. x all in cells. Caseous tubercle. *Nodule in the intestinal mucous membrane.*—19 sections. A normal solitary gland. No tubercle bacilli.
					D. killed in **233 days.**	D.—The *serous membranes* were normal. There were two small white spots on the *liver.* All the other organs, and all the *lymph glands* were normal. The *tongue, tonsils, and larynx* were normal, and the *intestinal tract* was perfectly normal throughout.

FEEDING EXPERIMENT in TWO CALVES with HUMAN TUBERCULOUS MATERIAL, 440 cc. of Sputum from Cases of Pulmonary Tuberculosis in Man.—EXPERIMENT II.

Date of Commencement of Experiment.	Number of Animals.	Quantity eaten.	Material used.	Duration of Feeding.	Killed in or Died in	Post-mortem Examination.
Feb. 10, 1893	2 calves -	440 cc. -	Sputum from 2 phthisical patients containing numerous tubercle bacilli.	1 day -	A. killed in **56 days**	**Tuberculosis.** A.—*Serous membranes* normal. *Lungs.*—The inner surface of the left lung, lower lobe, showed a transparent hard subpleural nodule. The rest of the lungs and all other organs were normal. Eight of the *mesenteric glands* showed caseous tubercle. The rest of the lymph glands were normal. In the Peyer's patches of the lower part of the *jejunum* and *ileum* were 12 nodules of tubercle with caseous centres. There was also one nodule of tubercle in the mucous membrane of the ileum. The *large gut* was normal throughout. *Microscopical Examination* :— Two cover-glass preparations of the mesenteric glands showed caseous matter and T.B. x. Two cover-glass preparations of a nodule from the small intestine showed degenerating cells and T.B. x.
					B. killed in **138 days.**	B.—The *serous membranes* were normal. All organs were normal. *Tongue, tonsils, and larynx* were normal. The *lymph glands* and the *intestinal tract* were also quite normal.

PLATE I.

(*To face page* 103.)

INQUIRY II.

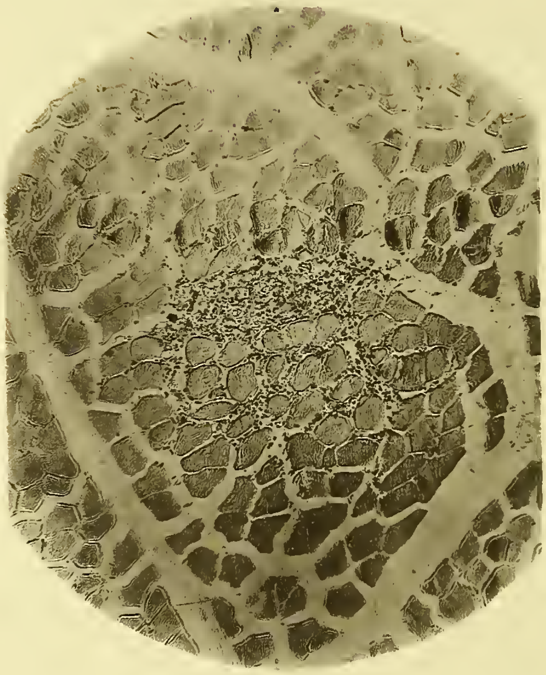

FIG. I.

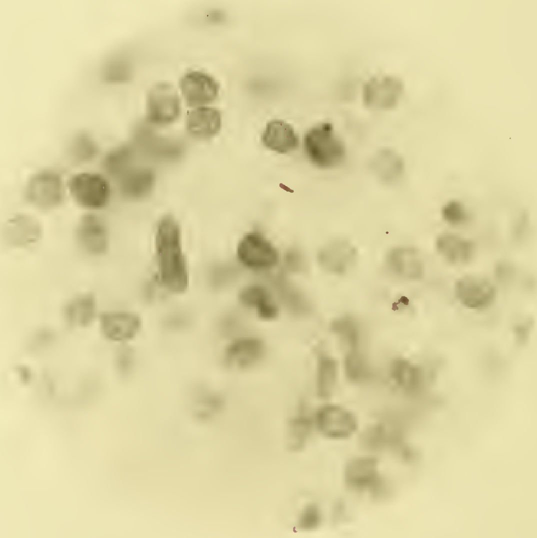

FIG. 2.

INQUIRY II.

PLATE I.*

TUBERCULOSIS OF MUSCLE.

Figure 1.

Miliary tubercle in the rump muscle of Cow 12: × 100 diameters (*see* Part II., p. 25).

The muscle-fibres are cut transversely, and in between them, at one spot, is seen a collection of small cells around two vessels which are faintly indicated. The small-celled infiltration is extending between the muscular fibres, as seen in the lower part of the figure. There is no degeneration of the cells.

Figure 2.

The same as Figure 1, but × 1.000 diameters, to show the tubercle bacillus which was found. The bacillus not lying quite flat; it measured in its oblique position 2·5μ in length, or $\frac{1}{10000}$ inch.

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* The reproductions of the photographs are by the Autotype Company.

INQUIRY II.

PLATE II.

Tuberculosis of the Udder.

Figure 3.

A photograph of a section of the tuberculous udder of Cow 20 (Part III., p. 37) × 35 diameters.

The changes shown are those of advanced tuberculosis of the udder. The secretory structures (acini) of the gland are not only widely separated by the deposit of tubercle, but are destroyed by compression, and are in some place full of cells, the products of the multiplication of the secreting cells (as on the left of the figure). The tuberculous nodules show advanced caseation.

Figure 4.

A photograph of the same specimen as in Figure 3, × 750 diameters, to show the large number of tubercle bacilli present in the tuberculous areas of the udder.

Figure 5.

A photograph of a specimen showing early tuberculosis of the udder from Cow 24 (Part III., p. 37), × 60 diameters.

On the left side of the figure the udder tissue is practically normal, the acini of the gland being well seen, showing only a small amount of fibro-cellular interstitial infiltration ; on the right of the figure, a fibrous septum of the udder is seen. Between the parts just described there is an area where the udder structure is absent, being replaced by a small-celled infiltration containing four or five giant cells. This is a tuberculous nodule. It contained tubercle bacilli. A few similar nodules were scattered throughout the rest of the udder tissue.

(*To face page* 104.)

INQUIRY II.

FIG. 3.

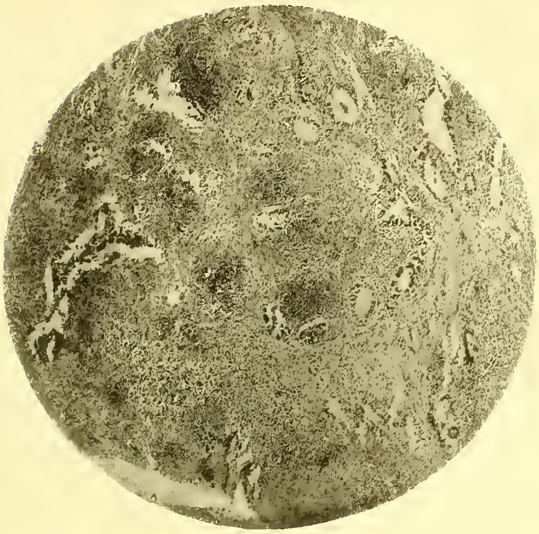


FIG. 4.

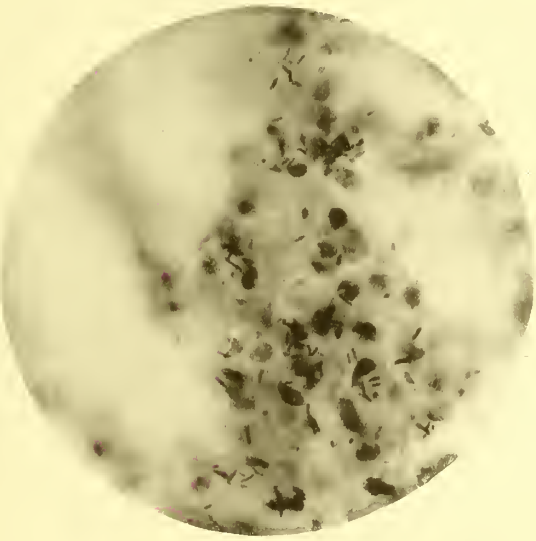
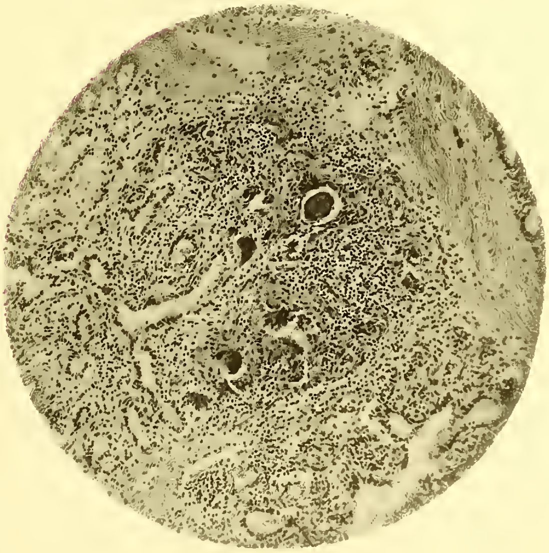


FIG. 5.



(*To face page* 105.)

INQUIRY II.

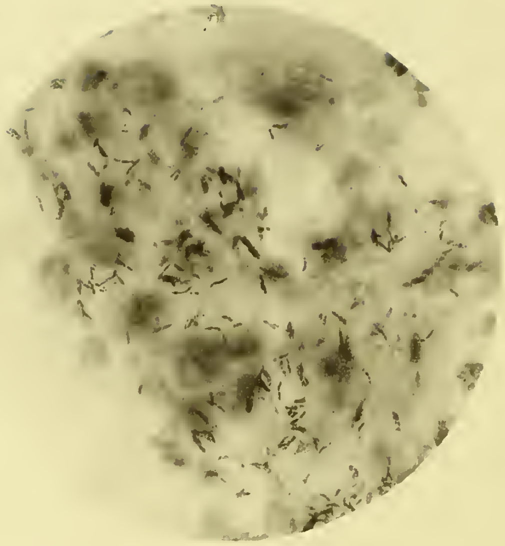


FIG. 6.

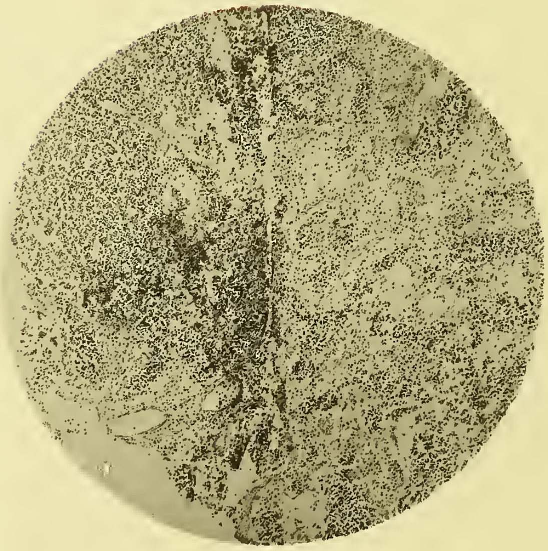


FIG. 7

INQUIRY II.

PLATE III.

Tubercle Bacilli in Milk, and Tuberculosis of Lymph Gland.

Figure 6.

A photograph of a mass found in the milk of Cow 20 with tuberculous disease of the udder, × 750 diameters.

The mass is composed of amorphous matter, a few degenerating cells with nuclei still intact, and very numerous tubercle bacilli, most of which showed the characteristic beading very well. Beaded tubercle bacilli are frequently met with in tuberculous milk side by side with the unbeaded rods seen in tuberculous lesions.

Figure 7.

A photograph of a section of a lymphatic gland showing very early tuberculosis, × 35 diameters.

The gland was the right supramammary gland of Cow 24, and showed no naked-eye tubercle. At one part of the figure to the left the gland structure appears condensed, and at this spot tubercle bacilli were found.

The figure is intended to demonstrate that tuberculosis of a lymph gland may be present when undetectable by the naked eye.

PLATE IV.

Bacterial Necrosis.

Figure 8.

Bacterial necrosis in the mucous membrane of the intestine of the guinea pig, × 60 diameters (Part VII., p. 74, Cow 15, Guinea-pig B., feeding experiment).

The photograph shows the lower part of a Peyer's patch with the muscular and peritoneal coats attached. In the lower part of the patch is a nodule separated from the surrounding normal lymphoid tissue and composed of round cells undergoing degeneration (necrosis). In the nodules are two or three dark areas, which, under a higher power, are seen to be groups of rods (bacilli). No tubercle bacilli were present. In the rest of the Peyer's patch were two or three similar necrotic areas.

Figure 9.

Bacterial necrosis in the pharyngeal mucous membrane of the pig, × 35 diameters (Part VII., p. 80, Cow 23; Pig fed on trimmed meat).

The photograph shows the nodule to be composed of a central clear area of necrosed cells, only a few of the nuclei of these being seen, and a peripheral zone of round cells (leucocytes). The nodule was sharply marked off from the healthy surrounding mucous membrane.

Figure 10.

A photograph of the same specimen as in Figure 9, × 750 diameters.

The necrosed area above is here seen, and shows a few cells, a great deal of amorphous matter, and very numerous cocci, mostly arranged in chains. This area showed in fact a pure culture of streptococcus. No tubercle bacilli were present. The necrosis was due to the streptococcus.

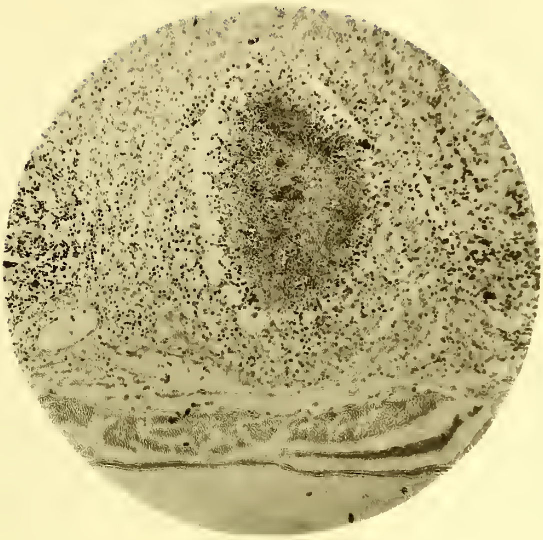


FIG. 8.

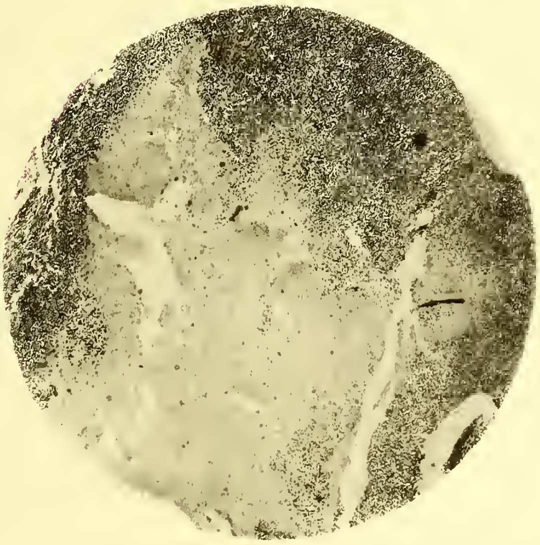


FIG. 9.

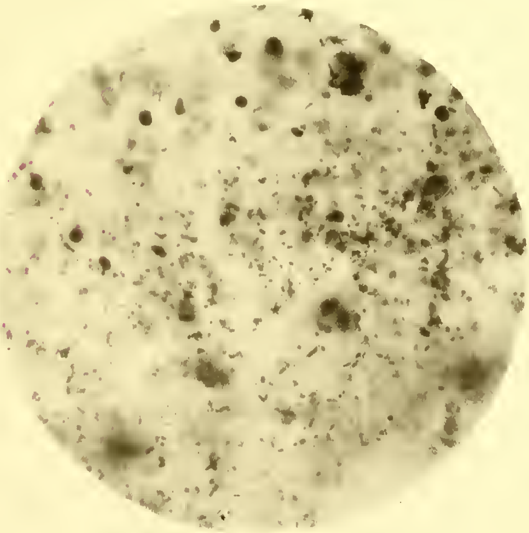


FIG. 10.

INQUIRY III.

As to how far Cooking Processes destroy the Infectivity of Tubercle.

Report by German Sims Woodhead, M.D., Director of the Laboratories of the Royal Colleges of Physicians (London) and Surgeons (England).

i The work of this investigation, begun in April, 1891, was not concluded until December, 1893. During the investigation I have received most valuable assistance in the collection of material from tuberculous animals from many quarters, but I desire to acknowledge my special indebtedness to Professor Bang, of Copenhagen, who not only sent a cow with a tuberculous udder from Denmark, but has supplied me with most valuable information and statistics; to Principal Brown, C.B., and the late Mr. P. D. Coghill, of the Royal Veterinary College, London; to the late Principal Walley, F.R.C.V.S., of Edinburgh; and to Dr. R. Sidney Marsden, of Birkenhead, and Mr. Sidney Villar, F.R.C.V.S., of Harrow. To Mr. G. Busck, of Copenhagen, who has placed much valuable information at my disposal and at great personal sacrifice of time has given me every facility for making a careful examination of his system of Dairy Inspection and Control as carried on in the Copenhagen Milk Supply Association; to Mr. Lidholm, for similar kindness in conducting me over the Stockholm Milk Supply Association and a large dairy farm connected with it, I am also laid under great obligation. To Mr. Samuel Rayment, F.R.C.V.S., Inspector of the Metropolitan Cattle Market, Islington, I am indebted for a large supply of tuberculous organs and of meat from tuberculous cattle, without which it would have been impossible for me to complete the investigation, and to Dr. Fyffe, of Victoria Park Hospital for Diseases of the Chest, who placed at my disposal a large quantity of human tuberculous sputum which in the later heating (for sterilisation purposes) experiments was invaluable. In the recording of results, the preparation of material, the staining and examination of sections, and cover-glass preparations of which over 10,000 were made during the investigation, and in the preparation of the report, I have received most valuable assistance from Mr. James Millar.

In the scientific and practical working of the investigation I have been greatly aided by Dr. Cartwright Wood, without whose assistance I should have been unable to complete the necessary experimental work even in the somewhat lengthened period over which the investigation has extended. Dr. Wood has, indeed, by his assistance and advice, contributed very materially to the value and thoroughness of the investigation, and I take this opportunity of placing on record my sense of indebtedness to him for the willing fashion in which he has placed his time, energy, and ability at my disposal in helping to carry out a long series of exacting experiments, and to make deductions from the results obtained.

Object of the Inquiry.

ii The object of this inquiry, as laid down in the recommendation by the Royal Commission, is "to " determine how far cooking processes destroy the " infectivity of tubercle."

"Using for this purpose demonstrably tuberculous " material, taken as milk, flesh or organs, and proved " always by control experiments to be infective to " susceptible animals."

"To find under what circumstances of cooking each " specimen may be deprived of its power of infecting " susceptible animals fed with it, and to define the " limits of the conditions for effectual disinfection by " cooking processes."

The results of this enquiry are considered under the following headings:—

Part I.—General description of places of experiment and of the animals used for experiment; conditions under which the experiments were carried out; the difficulties of keeping the premises from becoming infected, and the means adopted to eliminate cases of accidental infection that might have occurred in one series of experiments carried on during a period when the stock was open to the suspicion of being accidentally infected.

Part II.—Feeding and inoculation experiments with raw or plunged meat taken from cows with mild, moderate, or advanced tuberculosis.

- (*a.*) From the neighbourhood of tuberculous glands.
- (*b.*) From beneath the costal pleura where such pleura was visibly affected with tuberculosis.
- (*c.*) From the muscles of the abdominal wall where there was tuberculosis of the parietal peritoneum.
- (*d.*) With flesh taken from beneath the healthy pleura or peritoneum of animals in which the tuberculosis was confined to the visceral organs and to the visceral pleura or peritoneum.

Part III.—Feeding and inoculation experiments with meat from the same cows:—

- (*a.*) Boiled;
- (*b.*) Roasted,

as for use at the table.

Part IV.—Feeding and inoculation experiments (with controls) with manifestly tuberculous material; glands, lung, udder, etc.:—

- (*a.*) Boiled;
- (*b.*) Roasted.

Part V.—Feeding and inoculation experiments (with controls) with meat purposely contaminated with tuberculous material:—

- (*a.*) Boiled;
- (*b.*) Roasted,

as for use at the table.

Part VI.—Temperature experiments carried on with fusible metal placed in meat that was afterwards boiled or roasted.

Part VII.—Temperature experiments carried on with thermometers placed in meat which was afterwards subjected to the process of boiling or roasting.

Part VIII.—Feeding and injection experiments (with controls) with milk, taken from cows with tuberculous udders, heated at various temperatures.

Part IX.—Feeding and injection experiments (with controls) with milk, to which manifestly tuberculous material had been added, heated at various temperatures.

Part X.—Details of post-mortem examinations of cows from which tuberculous meat and organs were obtained for experiments, with details of experiments on animals.

Part XI.—Details of cooking experiments with meat rendered infective by the addition of obviously tubercular material:—

- (*a.*) Boiling;
- (*b.*) Roasting.

Part XII.—Details of experiments made with milk from cows with tuberculous udders.

Part XIII.—Details of experiments made with milk artificially rendered virulent by the addition of manifestly tubercular material.

Part I.

General Description of Places of Experiments and of the Animals used for Experiment; Conditions under which the Experiments were carried out; the Difficulties of keeping the Premises from becoming Infected, and the Means Adopted to Eliminate Cases of Accidental Infection that might have occurred in one series of Experiments carried on during a period when the Stock was open to the suspicion of being Accidentally Infected.

1 The experimental part of the work was carried out in a stable with outhouses situated near the London, Brighton and South Coast Railway line, Boundaries Road, Balham, S.W. This stable was fitted with twelve pig styes, two cow stalls, and cage accommodation for about two hundred guinea-pigs. The floor was concreted. The place was thoroughly well ventilated, and during the time that cows were being kept most of the smaller animals were transferred to a separate building.

Stable an
outhouses
at Balham

Accommo
dation.

2 After each set of cows and pigs had been slaughtered, the walls and roof of this stable were washed with quick lime and the floors and wood work were from time to time thoroughly sterilised with carbolic acid. Special disinfections were carried out after the death of Cows Nos. 9 and 33.

Method o
disinfecti
the stabl

dditional hed for uinea-pigs nd cats.

3 In the yard a large covered shed was fitted with cages in which, during the greater part of the year, the guinea pigs were kept. This though protected from the north east wind was open on three sides so that it was ventilated very thoroughly and was thus admirably suited for keeping animals with which feeding experiments were being carried on. In the yard itself a number of larger cages were placed, protected from rain, but otherwise in the open air; in these and similar cages in the open shed the cats experimented upon were housed.

Disinfection of cages

4 The cages were carefully isolated from one another, they were new for the first set of experiments and afterwards were thoroughly washed and scrubbed with hot water, then soaked with crude carbolic acid, and finally were re-painted with a black tar varnish. This disinfection was repeated after the completion of each set of experiments.

and feeding troughs.

5 The feeding troughs in which the food was given to the guinea pigs and cats were made of zinc so that they could the more readily be subjected to scalding. They were each day, while a feeding experiment was in progress, sterilised by being plunged into boiling water, in order that the meat or milk placed in them might remain as fresh as possible.

6 The cow and pig troughs were made of earthenware and cement and were systematically sterilised by the methods above described for the sterilisation of the cages (thorough washing, carbolic acid, and rinsing with boiling water) between each series of experiments.

7 One litter of pigs, after being kept for some time at Balham, was sent out to Harrow in order to make room for another litter with which a fresh series of experiments was to be carried on.

Laboratory shed.

8 As it was advisable to do much of the work in a room under cover and separate from the places in which the animals were kept, it was found necessary to erect a corrugated iron structure in which all the sterilising experiments might be carried on and in which too there was accommodation for developing photographic plates, and where apparatus and material might be stored, and the staining and examination of coverglass preparations carried on. This building, though small, served most admirably the purposes for which it was designed, and the work of investigation was greatly facilitated by having so convenient a structure on the premises. Some of the microscopic work was carried on at the laboratories of the Royal College of Physicians (London) and Surgeons (England), and I beg to thank the Laboratories Committee for permission to avail myself of the facilities there afforded for carrying on such work. I also wish to thank the laboratory assistant, Mr. Doudney, for much help in the preparation of microphotographic representations of certain of the lesions accompanying the report.

Labora-tories of the Royal Colleges.

General Method of Inquiry.

9 In order to collect fairly complete data from which to argue and obtain definite answers to the various questions raised in the "enquiry as to how far cooking "processes destroy the infectivity of tubercle," it was necessary to carry on a considerable number of collateral experiments under carefully defined conditions, care being taken to eliminate as many sources of error as possible. It was at first thought that it would be necessary to use a large number of different species of animals, but after a series of preliminary experiments had been carried on, it was concluded that guinea pigs, cats, and pigs, would serve our purposes best, not only because they could be most conveniently obtained but also because they would give the most reliable results. Guinea pigs might be taken as representing the herbivora, cats the carnivora, and pigs the omnivora. All three species are known to be susceptible to tuberculosis under certain conditions, though none of them take it unless they are brought directly under the influence of tuberculous infective material. They can all be kept in somewhat limited quarters, and, perhaps most important of all, they can all be obtained in families, and any single series of experiments may be carried on with members of the same litter, so that not only the surroundings, but the general and hereditary conditions are in all cases as similar as possible.

Animals used.

Advantage of using guinea-pigs, pigs, and cats.

The animals used for experimentation were as far as possible kept in families (the first 150 guinea-pigs, and some 60 or 70 that were bred on the premises and a few of those that were bought in, were all kept in families), so that animals as like as possible in constitution and hereditary characteristic might be used in each series of experiments. Each of these litters of guinea-pigs was divided into three sets; one set was used for feeding experiments, a second for inoculation, and the third for control experiments; in the case of pigs and kittens whole families or litters for the different series of experiments were always obtained.

Object of inquiry.

10 As the object of the enquiry was to determine how far the action of heat interferes with the infectivity of tuberculous material that may at any time be used for food, it was necessary to have in every case a series of control experiments.

Control animals.

11 As nearly all the animals used in the experiments were taken from the stock kept at the laboratories of the Royal Colleges of Physicians (Lond.) and Surgeons (Eng.), all guinea-pigs used in these laboratories for other work served as additional controls. During the whole period that our investigations on tuberculosis were proceeding not a single animal used for other purposes showed any signs of accidentally acquired tuberculosis.

Vitiated e periments

12 In one series of experiments eliminated because of the suspicious nature of the tubercle present, animals had been bought in a hurry direct from a dealer in Seven Dials, and amongst these animals were found several which were undoubtedly tubercular, in one case at least the lesion being the result of infection by inoculation, as there was a typical tubercular wound in the groin accompanied by all the general lesions usually associated with this inoculation, and it was evident that owing to gross carelessness on the part of some experimenter these animals had been resold to the dealer.

Mortality amongst stock.

13 The general death rate amongst the animals set apart for use in these experiments has been very low. On three occasions, however, there was a sudden rise in the mortality: (1) 30 animals died within a short time of their being put into the building, death being probably due to change of diet. This has frequently been noticed at other laboratories, especially when the animals come in hungry; (2) 23 animals died from pneumonia; and (3) 24 animals died during the intensely cold weather of Christmas, 1891. (During this period a number of the animals experimented upon also succumbed). The total number of animals that died from stock during the course of the investigation was 186.

14 A record was kept of the appearances (naked eye and microscopic) presented in every one of the 186 guinea-pigs above-mentioned, consequently these serve as excellent control experiments, and show that as amongst the large number of animals that died unexperimented upon (with the exception of the case mentioned) there was no spontaneous tuberculosis, the large proportion of tuberculosis in the animals experimented on must be accepted as due to the conditions of experiment. Most of the animals were kept under observation for some time before they were used for experimental purposes, so that had they been previously infected they would either have died before being experimented upon, or if experimented with would have indicated by the appearances after death that the disease must have been previously acquired, as tubercle in a guinea-pig naturally runs a comparatively rapid course.

The animals were well fed, and their pens and cages were cleaned, and fresh bedding put in every other day.

Care and condition animals.

15 All experimental animals in which no tuberculosis was found improved in weight and condition. The effect of the presence of tubercle was specially marked by the absence of omental fat.

A few comparative experiments were made with pure cultures of the tubercule bacillus and with material from tuberculous glands, and as the results were the same in both cases, the cultures were discarded and tuberculous material from pigs, cattle and human phthisical beings was afterwards used, the latter, as is known, not being so easily disinfected as the former.

Part II.

Report on Feeding and Inoculation Experiments with Raw or Plunged Meat taken from Cows with Mild, Moderate, or Advanced Tuberculosis.

Object of the Investigation.

16 To ascertain whether the raw meat of tuberculous cows was capable of producing tuberculosis in animals

fed or inoculated with it, in order to control what might be obtained in connexion with the feeding and inoculation experiments made with boiled or roasted meat taken from the same or similar tuberculous cows.

General Method of Procedure.

17 The meat used was taken :—

(*a.*) From the neighbourhood of tuberculous glands ;

(*b.*) From beneath the costal pleura, where such pleura was visibly affected with tuberculosis ;

(*c.*) From the muscles of the abdominal wall where there was tuberculosis of the parietal peritoneum ;

(*d.*) From beneath the healthy pleura or peritoneum of animals in which the tuberculosis was confined to the visceral organs, and to the glands connected with them.

18 In the course of these experiments the meat from 26 carcases of tuberculous cows was obtained, but in several cases it was forwarded in such a condition and so packed in contact with tuberculous organs and parts that it was decided not to use it for raw meat experiments, the material in these cases being set aside for feeding and inoculation experiments devised for the purpose of determining the effects of heat in bringing about the death or attenuation of the tubercle bacillus.*

19 With the flesh and organs of one animal, Cow No. 21, a large series of experiments was carried out, but in the course of certain of these it was found that one batch of guinea pigs, to which reference has already been made, from which the experimental animals had been taken was not to be relied upon, as certain of them were found to be in an advanced stage of tuberculosis a week after delivery at the laboratories. The whole of this series of experiments is therefore excluded from the tables of results.

20 The results obtained were exceptional in so far as one of the three guinea pigs used for meat-feeding experiments became tubercular. It must be noted, however, that Dr. Martin, using the same meat (Cow No. 21), obtained a similar positive result.

21 Nineteen carcases were obtained in such good condition and had been removed and transported with such precautions that they could be used for experimental purposes. In several instances both Dr. Martin and I were present at the post-mortem examination† ; in the others I made the post-mortem examination myself, and in two instances neither my assistants nor I could be present, and the note describing these cases was sent by Mr. Rayment, the Veterinary Inspector of the Metropolitan Cattle Market ; in the case of sixteen of the cows a complete post-mortem examination was made. A record of these post-mortem examinations and a description of the lesions in the tubercular organs (of which a careful note was made and recorded in order that the results of the experiments might afterwards be considered in the light of the information afforded by the condition of the animals from which the material used for experiment was taken) will be found in the detailed report, *see* Part X., pp. 181–207.

Method of taking and preparing Meat used for experiment.

22 After careful examination of the carcase, the butcher was requested to dress it in the ordinary way, the pleura being removed and the organs taken out as carefully as possible ; the cervical, lumbar and popliteal glands were examined and then portions of meat were cut out at our direction. The joints used were sirloin, outlift, buttock or rump, inlift or inside of the thigh, intercostal muscles—in some cases with the muscular part of the diaphragm attached— these being removed with several ribs, the muscles of the abdominal wall and the shoulder. In two cases (Cows Nos. 1 and 22), the tubercular pleura was not stripped from the inside of the chest, but was left attached to the ribs and intercostal muscle and was cut in one piece from the chest wall. As most of these joints were obtained for cooking purposes they were cut in as solid blocks as possible in order that the centre of the joint might be some distance from the surface.

Mode of transit.

23 The meat was taken in the usual way, but in all cases where it was used for experiment the greatest care was exercised to keep it and the tuberculous organs and parts quite apart (in separate vessels) during transit to Balham.

The tin cans in which the meat was conveyed to Balham from the Metropolitan Cattle Market, Harrow, and the Royal Veterinary College were in each case carefully sterilised by means of thorough boiling in the steam steriliser for at least half-an-hour. In several instances the meat was sent in hampers, often in contact with obviously tuberculous material ; such meat could only be used in "plunging" experiments, where the effects of surface contamination could, with certainty, be excluded.

Method of preparing meat.

24 The meat that was used raw was minced at once and portioned out into small packets, each of which was carefully wrapped in paper and kept on ice in an ice safe as long as the meat remained free from taint. It was found that the animals, especially the guinea pigs, sometimes refused to take the meat after it had been kept three or four days, and therefore did not receive the quantity originally set aside for them. The cooked meat was treated in a similar manner. Every precaution was taken to keep the ice safe free from contamination.

Difficulties as regards feeding experiments.

Classification of meat.

25 The meat that was used for these experiments may be classified under two headings, viz. :

Raw meat.

(1) Raw meat which, although it might have been accidentally contaminated during the processes of killing, dressing and cutting up was given (after mincing) to the animals just as it came from the butcher without treatment of any kind.

Plunged meat.

(2) Plunged meat ; that is, meat kept in boiling water for five or ten minutes in order that the possibility of infection from any such accidental contamination as above described might be eliminated. Here the thin outer discoloured layer was cut off with sterilised knives and only the raw central portion was used for feeding and inoculation purposes. In this manner all risk of external contamination was entirely done away with, whilst the central part retained for the experiments remained unchanged.

Methods feeding.

26 The minced meat was, in the earlier experiments, mixed with meal, bran, or chopped green food, but in the later experiments, in order that there might be as little *dilution* of the material as possible, it was given without any such admixture. The quantity given varied very considerably ; in some cases the meat would not keep nearly so well as in others. The average amount received by each guinea pig was about 150 grammes (equal to about one-third the weight of the animal), but a few received less than 100 grammes. Cats received about the same proportional weight to their body weight, but in the case of pigs the proportion varied very considerably and had to be determined by the amount of meat available.

Quantity taken.

27 In the feeding experiments carried on with guinea-pigs sometimes three and sometimes six animals were used in each series, each set of three living in the same cage and feeding from a common trough. Between each feeding the troughs were carefully cleaned out and sterilised by means of boiling water. In addition to the feeding experiments subcutaneous inoculations were made. In the subcutaneous inoculation experiments, a small fragment of meat about the size of a small bean was inserted under the skin of the abdomen in the region of the groin ; this fragment was cut from the surface of the raw meat or taken from the centre portion of the plunged meat, according to the nature of the experiment. In order that a comparison may be instituted between these experiments and those carried on in connexion with Inquiry No. II., the following

Cleaning of troughs.

Subcutaneous inoculation of meat.

Experiments with raw and with plunged meat.

---

* In these sets the control experiments with raw meat carried out by Dr. Martin who had been present at the cutting up of the carcase are sometimes made use of also, but this is always stated when such was the case.

† Every cow mentioned in this report is numbered. As Dr. Martin and I both used some of the cows (13), whilst in addition Dr. Martin used some (14) which I did not, and I some (6) which he did not, we have agreed to number these cows consecutively, so that any number, whether it occurs in the Report on Inquiry II. or in that on Inquiry III., always refers to the same cow.

tables concerning raw meat (corresponding to the untrimmed meat of that Report) and plunged meat (corresponding to Dr. Martin's trimmed meat) are given. The tables (I., II., III., and IV.) are as far as possible arranged in the same manner in order that the two sets of cases may control one another and also in order that, as occasion requires, Dr. Martin's results may be utilised as additional controls to the cooking experiments recorded in other parts of this Report. Thus, the cases are divided into those affected with—(1) *mild tuberculosis*, (2) with *moderate tuberculosis*, (3) with *advanced and generalised tuberculosis*, this classification being adopted after consultation with Dr. Martin. The details of each case are recorded in the post-mortem examinations of the various animals (*see* Part X., pp. 181–207), the state of nutrition of the animal, the condition of the flesh, the organs or parts affected with tuberculosis, and especially the condition of the pleura and parietal peritoneum, being noted. A special note was also made as to the condition of the kidneys, which, when affected, should rank equally with tubercular lumbar and popliteal glands, and with a tubercular condition of the costal pleura and parietal peritoneum, as evidence of commencing generalisation of the tuberculous process, especially when it is associated as is very frequently the case, with well marked emaciation.

Classification of cases of tuberculosis in cows.

Explanation of Tables.

28 In these tables (Nos. I., II., III., and IV.), the number of the cow from which the meat was obtained for experimental purposes is given in the first column; any single number refers to the same cow, whether used in identifying a cow mentioned in this Report or in Report No. II.: of course some appear in this Report only, but the numbers have been so arranged that no confusion can arise. Beneath each number the extent and nature of the tuberculous affection of the cow is given in black letter. In the centre column the part of the carcase used for experiment is recorded; whilst in the last column the condition (raw or plunged in boiling water) is indicated. These three columns refer to the whole table. To the left of the central column the inoculation experiments are given; on the right, the feeding experiments. In each of these sub-tables the number of animals used in each experiment is given in the first column; the material used in the inoculation experiments and the amount given in the feeding experiments is placed in the second column; in the third column the number of animals that survived long enough to allow of any use being made of the experiment is given; and in the last column the result in each case is recorded. At the bottom of each table the general results are summed up under the same headings.

TABLE I.

Feeding and Inoculation Experiments with Raw and Plunged Meat from Cows affected with Mild Tuberculosis.

No. of Cow. — Parts affected with Tuberculosis.	SUBCUTANEOUS INOCULATION EXPERIMENTS.				Portion of Carcass used.	FEEDING EXPERIMENTS.				Raw or Plunged in Boiling Water.
	No. of Animals in each Experiment.	Material used.	Result with Animals that lived over 21 Days from first Inoculation.			No. of Animals in each Experiment.	Amount of Meat in Grammes and Lbs.	Result with Animals that lived over 28 Days from first Feeding.		
			No. of Animals.	Result.				No. of Animals.	Result.	
28. **Glands in thorax, liver lumbar gland.**	..	..	..	..	**Rump.**	3 guinea-pigs.	300 grammes. (10½ ozs.)	3	Nil.	**Plunged.**
6. **Pleura, glands in thorax, lumbar glands.**	2 guinea-pigs.	Meat.	2	Nil.	**Rump.**	4 guinea-pigs.	600 grammes. (1 lb. 5 ozs.)	4	Nil.	**Plunged**
	2 guinea-pigs.	Meat.	..	Died too early.	**Rump.**	4 guinea-pigs.	600 grammes. (1 lb. 5 ozs.)	4	Nil.	**Raw.**
					Intercostal* muscles.	1 cat.	1,000 grammes (2 lbs. 3 ozs.)	1	Nil.	**Raw.**
						1 kitten.	1,000 grammes (2 lbs. 3 ozs.)	1	Nil.	**Raw.**
16. **Liver, glands in thorax, lungs.**	1 guinea-pig.	Meat.	1	Nil.	**Rump.**	6 guinea-pigs.	800 grammes. (1 lb. 12 ozs.)	5	Nil.	**Plunged.**
1. **Pleura.**	..	..	..	..	**Rump.**	6 guinea-pigs.	600 grammes. (1 lb. 5 ozs.)	6	Nil.	**Plunged.**
30. **Lungs, and glands in thorax.**	2 guinea-pigs.	Meat.	2	Nil.	**Rump.**	6 guinea-pigs.	440 grammes. (15½ ozs.)	6	Nil.	**Plunged.**
General results, 5 cows.	..	..	**5 animals inoculated with plunged meat.**	**Nil.**	..	..	..	**30 animals fed.**		
								24 with plunged meat,	**Nil.**	
								6 with raw meat.	**Nil.**	

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* The pleura stripped from the surface of the chest was distinctly tubercular, and gave tuberculosis to 2 guinea-pigs inoculated subcutaneously with it, though 4 guinea-pigs fed with the same material were unaffected.

TABLE II.

Feeding and Inoculation Experiments with Raw and Plunged Meat from Cows affected with Moderate Tuberculosis.

No. of Cow. — Parts affected with Tuberculosis.	Subcutaneous Inoculation Experiments.				Portion of Carcass used.	Feeding Experiments.				Raw or Plunged in Boiling Water.
	No. of Animals in each Experiment.	Material used.	Result with Animals that lived over 21 Days from first Inoculation.			No. of Animals in each Experiment.	Amount of Meat in Grammes and Lbs.	Result with Animals that lived over 28 Days from first Feeding.		
			No. of Animals.	Result.				No. of Animals.	Result.	
10. Lungs, glands in thorax, lumbar glands.	2 guinea-pigs.	Meat.	1	Nil.	**Rump.**	3 guinea-pigs.	350 grammes. (12¼ ozs.)	3	Nil.	**Plunged.**
					Intercostal muscle and abdominal wall.	3 guinea-pigs.	700 grammes. (1 lb. 8½ ozs.)	3	Nil.	**Plunged.**
15. Pleura, lungs, glands in thorax.	2 guinea-pigs.	Meat.	..	Died too early.	**Rump.**	6 guinea-pigs.	600 grammes. (1 lb. 5 ozs.)	5	Nil.	**Plunged.**
	2 guinea-pigs.	Meat.	..	Died too early.	**Rump and abdominal wall.**	6 guinea-pigs.	600 grammes. (1 lb. 5 ozs.)	6	Nil.	**Raw.**
	2 guinea-pigs.	Meat.	2	Nil.	**Intercostal muscles.**	6 guinea-pigs.	600 grammes. (1 lb. 5 ozs.)	6	Nil.	**Raw.**
11. Lungs, glands in thorax.	..	..	..	..	**Shoulder.**	6 guinea-pigs.	500 grammes. (1 lb. 1½ ozs.)	6	Nil.	**Plunged.**
12. Lungs, glands in thorax.	..	..	..	..	**Muscle from foreleg.**	3 guinea-pigs.	150 grammes. (5¼ ozs.)	2	Nil.	**Plunged.**
	3 guinea-pigs.	Meat.	3	Nil.	**Muscle from foreleg.**	3 guinea-pigs.	150 grammes. (5¼ ozs.)	3	Nil.	**Raw.**
General Results, 4 cows.	..	..	**6 animals inoculated.**					**34 animals fed.**		
			1 with plunged meat, 5 with raw meat.	**Nil. Nil.**				**19 with plunged meat, 15 with raw meat.**	**Nil. Nil.**	

TABLE III.

Feeding and Inoculation Experiments with Raw and Plunged Meat from Cows affected with Advanced or Generalised Tuberculosis.

No. of Cow. — Parts affected with Tuberculosis.	Subcutaneous Inoculation Experiments.				Portion of Carcass used.	Feeding Experiments.				Raw or Plunged in Boiling Water.
	No. of Animals in each Experiment.	Material used.	Result with Animals that lived over 21 Days from first Inoculation.			No. of Animals in each Experiment.	Amount of Meat in Grammes and Lbs.	Result with Animals that lived over 28 Days from first Feeding.		
			No. of Animals.	Result.				No. of Animals.	Result.	
19. Pleura, lungs, udder, glands in thorax.	..	..	..	..	**Rump.**	3 guinea-pigs.	750 grammes. (1 lb. 10 ozs.)	3	Nil.	**Plunged.**
20. Pleura, peritoneum, lungs, intestines, thoracic and lumbar glands, udder.	..	..	..	..	**Rump, intercostal and abdominal muscles.**	4 guinea-pigs.	300 grammes. (10½ ozs.)	3	Nil.	**Raw.**
22. Pleura, peritoneum, lungs, intestines, thoracic glands, kidneys, uterus, lumbar glands.	..	..	..	..	**Rump.**	6 guinea-pigs.	500 grammes. (1 lb. 1½ oz.)	5	Nil.	**Plunged.**
					Rump.	6 guinea-pigs.	500 grammes. (1 lb. ½ oz.)	6	Nil.	**Raw.**
29. Lungs, pleura, thoracic glands, peritoneum. (Other organs not known.)	..	..	..	..	**Rump.**	6 guinea-pigs.	450 grammes. (16 ozs.)	6	Nil.	**Plunged.**
					Rump.	1 kitten.	370 grammes. (11 ozs.)	—	Died too early.	**Plunged.**
31. Lungs, pleura, thoracic glands, and abdominal organs.	2 guinea-pigs.	Meat.		Nil.	**Thigh.**	6 guinea-pigs.	440 grammes (15½ ozs.)	5	Nil.	**Plunged.**

TABLE III.—*continued.*

No. of Cow. Parts affected with Tuberculosis.	Subcutaneous Inoculation Experiments.				Portion of Carcass used.	Feeding Experiments.				Raw or Plunged in Boiling Water.
	No. of Animals in each Experiment.	Material used.	Result with Animals that lived over 21 Days from first Inoculation.			No. of Animals in each Experiment.	Amount of Meat in Grammes and Lbs.	Result with Animals that lived over 28 Days from first Feeding.		
			No. of Animals.	Result.				No. of Animals.	Result.	
23. **Pleura, peritoneum, lungs, intestines, thoracic glands, kidneys, axillary glands.**	3 guinea-pigs.	Meat.	2	Nil.	**Rump.**	3 guinea-pigs.	300 grammes (10½ ozs.)	2	Nil.	**Plunged.**
	3 guinea-pigs.	Meat.	1	Nil.	**Rump.**	3 guinea-pigs.	300 grammes (10½ ozs.)	3	Nil.	**Raw.**
32. **Glands in thorax, pleura, peritoneum, abdominal glands, kidneys, and suprarenal body, uterus, udder.**	3 guinea-pigs.	Meat.	1	**Tubercular**	**Abdominal wall.**	6 guinea-pigs.	600 grammes (1 lb. 5 ozs.)	6	Nil.	**Raw.**
33. **Pleura, glands in thorax, lung, abdominal glands, liver, kidneys, small intestine, uterus, udder.**	2 guinea-pigs.	Meat.	1	Nil.	**Rump.**	3 guinea-pigs.	400 grammes (14 ozs.)	3	**1 tubercular.** 2 nil.	**Plunged.**
	2 guinea-pigs.	Meat.	1	**Tubercular**	..	**1 pig**	3,500 grammes (7 lbs. 12 ozs.)		**Tubercular.**	**Raw.**
						3 guinea-pigs.	350 grammes (12¼ ozs.)	1	**Tubercular**	**Raw.**
General results, 8 cows.	..	..	**8 animals inoculated.**		..	..	..	**44 animals fed.**		
			5 with plunged meat,	**Nil.**				**24 with plunged meat,**	**1 Tubercular.**	
			3 with raw meat.	**2 tubercular.**				**20 with raw meat.**	**2 tubercular.**	

TABLE IV.

Summary of Results contained in the Three foregoing Tables.

Number of Cow. Degree of Tuberculosis.	Number of Animals Inoculated Subcutaneously with		Number of Animals that developed Tuberculosis with		Number of Animals Fed with		Number of Animals that developed Tuberculosis with	
	Plunged Meat.	Raw Meat.	Plunged Meat.	Raw Meat.	Plunged Meat.	Raw Meat.	Plunged Meat.	Raw Meat.
Mild Tuberculosis. 5 cows - -	5	—	Nil.	—	24	6	Nil.	Nil.
Moderate Tuberculosis. 4 cows - -	1	5	Nil.	Nil.	19	15	Nil.	Nil.
Generalised Tuberculosis. 8 cows - -	5	3	Nil.	**2 tubercular.**	24	20	**1 tubercular.**	**2 tubercular.**
Total 18 cows -	11	8	Nil.	**2 tubercular.**	67	41	**1 tubercular.**	**2 tubercular.**
	19 animals inoculated.		**2 developed tuberculosis.**		108 animals fed.		**3 developed tuberculosis.**	

Tubercular Cows.

Appearance: meat of cows that died from tuberculosis.

29 Some of the meat that we used for experiments, *i.e.*, that taken from animals that died, or were actually dying (when they were slaughtered to relieve them from a lingering death) from tuberculosis would undoubtedly have been condemned as unfit for human food on account merely of its physical condition. An inspector would have described much of it as sodden, pale, and watery, especially where the tuberculosis had become generalised and where the emaciation of the animal was very marked during life. On the other hand, much of the flesh even of that taken from the neighbourhood of tuberculous glands was still in fairly good condition as far as naked-eye appearances were concerned. In those cases, however, from which positive results were obtained, there was emaciation of the animal, accompanied by pallor of the muscles and some œdema of the connective tissues, not only between but around the muscles, in fact in almost every part of the body, but the meat would not, in all cases, have been condemned on this ground. In many of the cases, where the emaciation was extreme, but where the œdematous condition was not a characteristic feature, the muscles were extremely dark in colour, and the fat, where there was any, abnormally yellow. This was the case in Cow No. 9, in which caseous and fibroid areas were found in the muscle of the rump.

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In Cow No. 9 were large firm yellow fibroid patches in the muscular substance, caseous yellow specks and grey areas having a peculiar opalescent appearance, these latter varying in size from such as could only be detected by the naked eye to patches nearly one-third of an inch in diameter.

Microscopical Appearances.

30 The following appearances could be made out under the microscope; the firm bands were composed merely of a large amount of true fibrous tissue in which were embedded but few elongated or flattened connective tissue cells. The numerous pale yellow nodules about one-fourth of an inch in diameter, appeared to be composed of small cells, most of them in an advanced stage of caseous degeneration. These caseous areas, some of them embedded in the fibrous bands, formed a mass more than two inches in diameter, which was surrounded by a kind of boundary zone of firm fibrous tissue; radiating from this were numerous fibrous bands similar to those above described and found in other parts of the same muscle. The smaller grey opalescent areas were also in the first instance supposed to be grey miliary tubercular granulations, but on microscopic examination it was found that they were due merely to a peculiar hyaline and granular degenerative change of the muscle fibres (Plate XV., Figs. 41 and 42.) Around these there was also a slight increase in the amount of interstitial tissue, but no further evidence of discrete tubercular granulations.

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31 The tubercle in Cow 12 has been fully described by Dr. Martin in his report as one in which minute miliary granulations, one of them containing a tubercle bacillus, were found between the muscle fibrils.

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It is interesting to note that both these instances of "intermuscular" tubercle occurred in cows suffering from what is classified as moderate tuberculosis, and that no microscopic or naked-eye evidence was obtained of the presence of either tubercular structure or bacilli in the flesh of animals classified as mild or as generalised cases. On the other hand, it is found that the only cases of tuberculosis produced by inoculation or feeding with tuberculous flesh were in those experiments where the meat from animals that are classified as suffering from generalised tuberculosis (in which, however, it was never possible to demonstrate the presence of tuberculous structure or the tubercle bacillus in the muscular or intermuscular tissues) was used.

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32 The positive results can then only be explained on the supposition, either that the tubercle bacilli were present in the inter-muscular spaces or in the connective tissue cut away along with the muscles; or that the distribution of the tuberculous lesions was so general that it was a difficult matter to cut out any joint or part of the meat without getting tubercle bacilli on to the surface of the meat, either through the agency of the knife (by which it might even be carried into the substance, as butchers constantly stick their knife into the carcase instead of putting it in the belt, or on a table, "in order that they may have it handy"), the hands, or the cloths which butchers use to wipe down the surfaces of the carcase during the process of dressing the animal.

The use of Tuberculin.

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33 In both those cases in which evidence of tubercle in the muscle has been found, Koch's tuberculin had been injected for diagnostic purposes. In the one case (Cow No. 12) the injection had been made only a couple of days before the animal was slaughtered; in this case minute miliary points were observed in the muscle; but if they had been developed in consequence of the injection, the action of the tuberculin must be extremely rapid, much more so than is usually imagined. It may be, however, that although these minute (microscopic) points were formed, it takes a somewhat longer period to produce the more marked lesions that have usually been described as the result of treatment with tuberculin; certainly in those cases of hæmorrhagic tubercular pleurisy and peritonitis in cattle, following the injection of tuberculin, that I have had the opportunity of examining, the period at which the animal succumbed or was killed has been much longer than two days, but then the general tubercular lesions were decidedly more marked. In the other case (Cow No. 9) where, according to the history of the case that we received from Mr. Coghill, the tuberculin had been injected some time before the animal came under our notice, there is ample evidence of the presence of lesions which may be those connected with old tuberculosis although no tubercle bacilli could be demonstrated in any part of these lesions. The most marked feature in this case is the formation of new fibrous tissue, giving rise to a kind of interstitial myositis. If this be really of tubercular origin, we have evidence of the extremely resistant nature of the tissues in which the tubercular inflammation has been set up.

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34 It appears as though, in this case, the tubercular process had, for a time, been able to make headway, and as if the tuberculin had held the inhibitory powers of the tissues in check during the time which it was capable of acting upon them. It may be that this inhibitory power remaining weakened as the result of the excessive stimulation of the cells that would take place during the early stages of the activity of the tuberculin, allowed of, or promoted the action of the tubercle bacilli which were thus enabled to determine the formation of tubercle granulations in abnormal positions. The tissues under these circumstances are in fact placed under much the same conditions as they are during advanced and generalised cases of tuberculosis, when the products of the bacillus growing in the tissues are formed in large quantities, and are thus necessarily at certain times diffused through the lymph and blood circulatory system. As soon, however, as the first effects of the large dose of tuberculin have passed off the naturally resistant vascular muscle with its delicate connective tissue framework, regains much of its old power, and the tubercular lesion is accordingly localised and is converted into or replaced by fibrous tissue, much of which is formed from the cells that have helped to destroy the tubercle bacillus.

35 As is usually the case in all conditions where fibrous tissue is formed in muscle, especially where this is the result of the action of an organic poison, the muscle fibres in or near the new fibrous bands are in a condition of hyaline degeneration, and it is quite possible that what to the naked eye often appear as small tubercular caseous areas are really the result of this hyaline degeneration. The small caseous areas are distinctly localised and cut off from the surrounding tissue by a well-marked fibrous zone or capsule.

The action of the Bacillus Tuberculosis.

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36 It is evident that in all these experiments, especially in the feeding experiments, the number of the bacilli or the quantity of the infective material introduced must play an important part in determining, first, whether the disease is set up at all; that is, whether a sufficient quantity is introduced to overcome the local resistance of the tissues at the point at which the material is presented to them, and, secondly, the rate of extension of the disease in those cases in which it is set up. In addition to the mere number of bacilli, it is necessary to take into account the nature of the animal experimented upon, and also the point at which the infective material attacks the animal; it is equally important to determine whether we introduce the products of the micro-organism along with the micro-organism itself. This latter factor is found to be of special importance in connexion with the introduction of the material into the alimentary canal, and it is one which has a distinct bearing on the formation of local lesions in this position. For example, in all our experiments with obviously tubercular material we were able to predict the formation of tubercular ulcers whenever considerable quantities of caseous gland, for instance, were administered, even though the number of bacilli that could be demonstrated under the microscope was comparatively small. The products found in the caseous material seemed to have the special power of causing a kind of rapid necrosis of the superficial tissues of the intestine. It may be, as has been suggested, that this is due to the action of the broken-down protoplasm of which the bacilli are composed, as similar results have been obtained by applying the dead bodies of the bacilli to connective or other tissues. Wherever this has been done, however, *there has been no secondary formation of tubercle;* although this poisonous material has a direct action on the tissues it does not appear capable of reproducing itself, and cannot thus be looked upon as a specific infective poison but merely as a local irritant, and it is only when a few tubercle bacilli are left alive in this caseous material that the secondary formations make their appearance at points some distance from the seat of

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the original ulceration. In many of our experiments where only a few tubercle bacilli were present in the material examined under the microscope, but where there had been no caseation, and where evidently this "corrosive" irritant substance could be present in exceedingly minute quantities only, it was often absolutely impossible to determine the presence of any local lesion at all in the superficial tissues of the intestines, although the mesenteric glands, the spleen, and the liver might be distinctly affected with what was evidently an infective tubercular process spreading from the alimentary canal. These facts will be further considered in relation to the production of tuberculosis by raw milk and raw glands, and also when we come to consider the effect of heating upon the tuberculous material.

37 To return, however, to the first question, the quantity of the specific infective agent that is required to set up spreading tuberculosis:—Only by careful attention to this question can the irregularity of the results obtained —markedly in the case of feeding experiments, and also sufficiently distinctly in the case of the inoculation experiments—be explained. It is for this reason that such relatively large pieces of meat (one-fourth to one-third of an inch in diameter) were placed in the subcutaneous tissues when the infectivity of meat was being tested by inoculation, and that such large quantities of meat were given in the feeding experiments.

"*Plunging*" *Experiments.*

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38 One most important feature in these experiments is that in only a single case where the meat was, as a preliminary procedure, plunged into boiling water for a few minutes (so that the evil effects of smearing, such as might have occurred during the process of dressing the meat, might be guarded against) was any tuberculosis set up either by feeding or inoculation. Even in those cases in which a few early isolated tubercular granulations (Cow No. 12) or old and quiescent tubercle (?) (Cow No. 9) were demonstrated in the muscular tissue no evil results ensued, and it would appear that in both these cases there must have been some special reason that the tuberculous material in those meats was innocuous.

39 In the inoculation experiments, even where pieces of considerable size were used, the tubercular granulations were so minute and discrete that the chances of including many active bacilli were reduced to a minimum,—the microscopic granulations described by Dr. Martin were so widely scattered, and the pieces of flesh used were so small that the chance of including a granulation with active bacilli was indeed very small.

40 In the feeding experiments the same factor may, of course, come into play, especially in the case of the guinea-pig, in which, as is well recognised, the meat is passed so rapidly through the alimentary canal that there is little opportunity for the digestive juices, which are not specially fitted to break down meat, to act upon it, with the result that there is the possibility that although bacilli were present in the meat, they may never have been able to come in contact with the intestinal wall.

In the case of Cow 9, the bacilli had entirely disappeared from the cicatricial tissue.

Possible Modes of Infection.

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41 As, however, isolated cases of tuberculosis were undoubtedly obtained as the result both of feeding (especially in the case of a pig, which took the meat readily and in large quantities) and of inoculation with these same meats when untrimmed, and of which the surface had not been sterilised by being plunged into boiling water, much of the real dangerous infective material must be looked for on the surface of the meat as it was supplied to us. The animals fed with this material undoubtedly became tubercular. The only explanation that can be given of this is that the meat that gave positive results must have been smeared with tuberculous material (1) derived from the organs or serous membranes that had come in contact with the butcher's knife, (2) or from being handled with his hands, which are only from time to time washed in *cold* water, which does not remove the fatty material contained in caseous matter, and which, in any case, is too perfunctory to remove bacilli that have become adherent to the hands, and (3) from the cloth with which the carcase is from time to time wiped down, to smooth down small cuts and fragments, and to remove fragments of fat, smears of blood, &c. It is obvious that although a very short period of ordinary cooking would, in most cases, as will be seen in Tables V. and VI., be quite sufficient to render meat perfectly innocuous if care be taken to remove, previous to cooking, all glands and similar tissues in which the tubercle bacilli might be harboured, this smearing may prove a distinct source of danger by spreading infection in at least two ways. These ways of infection are:—

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42 (1.) Where meat is cut off from joints, and is given raw to delicate children—a feeding treatment greatly in vogue at the present time; as the children to whom this meat is given are usually in bad health at the time, the danger is even greater than if they were in robust health, with all the resistance of the tissues and secretions in full activity. To guard against any possible danger in these cases, all that is necessary is to plunge the piece of meat into boiling water for five minutes, keeping the water boiling the whole time, and then to take the raw meat from the centre of these, shredding or pounding it in the usual fashion.

Rolled
meat.

43 (2.) The second danger of infection lies in meat, and especially second class meat, which is trimmed and rolled in order to make solid-looking blocks for cooking purposes; the results of experiments made with such rolls are very instructive. *See* pp. 123–129, Part V.

Degrees of Susceptibility of different Animals.

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44 We have evidence that a comparatively small number of tubercle bacilli can in certain species and under certain conditions set up marked and wide spread lesions. On the other hand, I have found from my experiments that although the cat is very much more resistant (especially to infection with tuberculosis by feeding) than either the pig or the guinea-pig, when it actually does become affected the number of tubercle bacilli formed, either in a local lesion (a lesion which may be extremely localised) or in the peritoneal cavity, is very great indeed, and in a series of experiments carried out for another purpose, it was found that in cats which succumbed to tubercle, whether by simple inoculation or through injection of a small quantity of the virus into the peritoneal cavity, an enormous number of tubercle bacilli could be demonstrated in the lesions. It appears as though it were necessary in order to cause a cat to succumb to tuberculosis, that there should be an enormous number of the specific bacilli present, whereas in the pig and in the guinea-pig comparatively small numbers may be quite sufficient to set up the tuberculous lesion. The factor of age in determining the susceptibility of the animal appears to be very important, especially in the case of cats. For example, large quantities of tuberculous material (lung and milk) each of which given separately proved fatal to guinea-pigs, appeared to have no effect on a well grown cat (cat in Table CV., p. 245), but when it was killed 77 days after the first feeding, it was found to have only a minute focus in one of the mesenteric glands, a focus, too, which appeared to be undergoing a healing process although tubercle bacilli, in considerable numbers, were demonstrable in the centre of the part. In kittens, on the other hand, fed or inoculated with obviously tubercular material, a considerable percentage of positive results was obtained; it was certainly much easier to produce the disease by injection in kittens than in full grown cats, although, as in the case of all animals, an injection was much more fatal to full grown cats than was feeding. To these points it will be necessary to make further reference again in connexion with the experiments with tubercular milk and artificial tubercular milk. Parts XII. and XIII., pp. 222 *et seq.*

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45 The most important outcome of this is that where tubercle bacilli are few in number, and where it is difficult to demonstrate them in the tissues, although the naked eye lesions are distinctly marked, there is often least natural or normal tissue resistance, whilst when these bacilli are numerous it is found, as in the case of cats, the horse, and even the cow and wild animals, that the tissue resistance in the first instance is very great, and that this can only be overcome by the combined action of a large number of tubercle bacilli, so that in these animals, when this tissue resistance is broken down, bacilli can always be readily demonstrated in the tissues wherever there is the slightest naked eye evidence of the presence of a tubercular lesion.

Number and Virulence of Tubercle Bacilli.

46 In the experiments made with the meat, raw and plunged, from tuberculous cows, the results obtained point very conclusively to the fact that the differences observed depend rather on the number of bacilli present, either in or on the surface of the meat, than on any actual change in the virulence or infective power of these bacilli. In the first instance, owing to the extremely irregular manner in which the positive results came out, it appeared as though there must be some diminution in virulence in certain cases; a careful examination of the course of the disease in those cases in which tuberculosis was produced by either feeding or inoculation rendered it evident, however, that in dealing with such susceptible animals as guinea-pigs, this was not necessarily the case. In these animals at any rate the course and history of the disease, except as regards rate of development, were so like that obtained in some or other of the cases in which the disease was induced by feeding or inoculation with obviously tuberculous material (such as the raw tubercular pleura from a tuberculous cow) that it was evident that the modification of the virulence must be of such a degree that it cannot be readily measured by any means at present at our disposal. On the other hand, ample evidence of the marked attenuating influence of heat on bacilli was frequently obtained in the later experiments.

Differences in Susceptibility of Animals to Attack at different points.

47 In arriving at a definition of a normal course and degree of tuberculosis, however, one is met at the outset by the fact that different animals display very different resisting powers, even those of the same species varying very markedly in their susceptibility to the disease; the age of the animal, its state of health, and the different conditions under which it is placed, all appearing to exert a most marked influence in determining this susceptibility. When we come to deal with animals of different species in which the conditions of feeding and the modes of life under normal circumstances are widely divergent, these differences in susceptibility to infection by tuberculosis are markedly accentuated.

48 When these experiments were commenced, I was certainly of the opinion that guinea-pigs were more susceptible to tuberculosis than pigs, and if the experiments had been confined to those carried on with raw tuberculous material I think that I should still have remained of the same opinion. A careful consideration of the feeding experiments made with milk from tuberculous udders and other obviously tuberculous material has, however, rendered it evident that this is a matter that requires much further consideration; as will be seen from a reference to Parts XII. and XIII. Although guinea-pigs and pigs appear to be equally susceptible to raw tuberculous material, it is found that when the same material is heated to a point at which it is rendered completely innocuous to guinea-pigs, 70 C°., for 30 minutes, Table No. CVII., we find that it still retains its virulence, as far as pigs are concerned, in a most marked degree, and from the quantity required to produce tuberculosis in these two kinds of animals, one would say, that taking the dosage for body weight into consideration, the pig is quite as susceptible as, or even more so than the guinea-pig, to the action of the tubercular virus. It is probable, however, that this greater susceptibility is due to the fact that the pig appears to be attacked from the tonsils and upper part of the pharynx much more frequently than is the guinea-pig, whilst, on the other hand, affection of the intestine is far more common in the guinea-pig than in the pig. This is not such an important point where meat is concerned, but in the case of tubercle bacilli introduced along with fluids into the alimentary tract of the animals, under which condition large quantities of fluids come in contact with the surface of the pharynx, it comes to be a very important factor in determining the point of entrance of tubercle bacilli into the tissues.

49 The lesions in the pig bear a remarkable resemblance to the lesions met with in scrofulous children, and it has been observed that in those lesions as well as in the caseous masses found in the guinea-pig, the number of tubercle bacilli to be demonstrated on microscopic examination is comparatively small; there are undoubtedly cases in which a very large number of tubercle bacilli have been found in all these lesions, but in the earlier stages, at any rate, it is a well-known fact that bacilli are sparsely scattered through the tissues, even when the degenerative changes appear to be extremely well marked.

General Conclusions.

50 From a consideration of the above facts it is evident that although in a small number of cases tuberculosis was developed as the result of the ingestion or inoculation of raw meat from tuberculous cows, infection only occurred where the meat from animals that had been affected with advanced and generalised tuberculosis was used; by carefully attending to the isolation of the raw meat from tuberculous cows it was possible in most cases to ensure its absolute freedom from any specific infective material. In the case of cows suffering from mild and moderate tuberculosis this was a comparatively easy matter when proper precautions were taken, as in the whole series of experiments not one single positive result was obtained from meat taken from such cows.

Contamination rare in mild and moderate tuberculosis.

51 With the meat taken from cows with advanced or generalised tuberculosis it was found in some cases to be impossible to obtain meat with its surface uncontaminated by the infected material even when the strictest precautions were taken to prevent the smearing of such meat with the juice or fatty or caseous matter of tuberculous foci or areas. It will be observed that with the raw meat taken from two cows, in which the tuberculosis was undoubtedly far advanced, positive results were obtained in the case of a pig and of a series of guinea pigs, and in both inoculation and feeding experiments. That it was usually due to smearing we have strong presumptive evidence in the fact that where the surface was sterilised by the suspected meat being plunged into boiling water before it was used for experimental purposes, the results were, with one exception, negative.

Frequent in advanced and generalised cases.

Due to "smearing."

52 In these cases of advanced and generalised tuberculosis I was fully prepared to meet with a much larger number of positive results than were actually obtained; it must be remembered, however, that the number of animals passing through our hands for experimental purposes was comparatively small, and that even to have obtained a small percentage of positive results indicates that there is a real danger of infection not only from the tuberculous carcases themselves, but also from the joints of healthy cattle, joints that have been cut, handled, or wiped with knives, hands, and cloths that have been used for the dressing of tuberculous animals.

A real danger.

53 It must also be pointed out that the other experiments clearly indicate that a much larger per-centage of positive results with raw meat would have been obtained had these been carried out on pigs instead of on guinea-pigs. It appears that guinea-pigs are not well suited for feeding experiments with such things as meat, in all probability because comparatively small quantities are absorbed, the remainder passing through the animal does not come in contact with the wall of the alimentary tract through which contact only, infection can ensue.

54 It must be borne in mind that tubercle granulations and caseous masses were actually found in the flesh of two cows used for experiment by Dr. Martin and myself (similar granulations have been found by Koch in the muscles of pigs), although in one case these granulations were only microscopical in character, and only a very small number of tubercle bacilli was present, their presence at all in these cases indicates the possibility of a similar condition occurring in a larger number of cases. It is, therefore, evident that the greatest care must be exercised by inspectors not to allow meat subject to such contamination to be sold for consumption.

55 It is obvious that where there is any naked-eye evidence of tubercle in any part or organ such part or organ should not be utilised as food; the other organs not obviously affected but in the same cavity as the affected organ should also be condemned as unsuitable for food.

No organs from an affected cavity to be used for food.

56 Although the results obtained in every case by both feeding and inoculation with the tubercular flesh from the animals affected only with mild or moderate tuberculosis, and injected with tuberculin, were negative, we cannot shut our eyes to the fact that similar lesions in glands and organs being capable of producing

No tubercular animal in which tuberculin has been injected to be used for food.

tuberculosis, we should be running a grave risk in recommending that the flesh from tuberculous cattle in which Koch's tuberculin had been used be allowed to be put on the market. In the two specific cases the flesh did not apparently contain sufficient infective material to produce tuberculosis either by feeding or by inoculation in guinea-pigs, although the flesh from other animals in which no evidence of tubercular lesions could be demonstrated in the flesh was, when given in the raw condition, quite capable of producing tuberculosis in either manner.

57 Although the number of experiments carried out under this head of the inquiry was comparatively small, the results obtained all point to the fact, that although the danger arising out of the presence of these demonstrably tubercular lesions in the flesh is considerable, such danger is comparatively slight compared with that which arises out of the infection during the dressing of the animal of the whole of the surfaces of the "joints" that are prepared. These smeared surfaces as we have seen come in contact with the tables, knives, and hands, not only of those who actually dress the animals but also of those into whose charge such meat afterwards passes. It is also probable that we should have had a much greater chance of obtaining a positive result in those cases where the tubercle was present in the muscle had such an omnivorous animal as a pig been fed on it, as in that case, from the fact that the meat is in large part absorbed from the intestinal canal, there would have been a much greater probability of the tubercle bacilli coming in contact with the intestinal mucous membrane, and thereby infecting the animal. This, then, is a source of extreme danger, especially in the case of cows in which the disease is generalised and advanced, and in which there are tubercular masses in the glands and organs, and actively growing grapes, and other tubercular growths on the serous surfaces on the abdominal and thoracic walls; all such masses contain numerous tubercle bacilli and form foci of infection so widely disseminated that the animal cannot be cut up or dressed without the knives, &c. cutting through and coming directly in contact with infective material.

Carcases in which tuberculosis is advanced should all be condemned as unfit for food.

58 On these grounds I am decidedly of opinion that all animals suffering from advanced and generalised tuberculosis, whether cow, calf, or pig, should be condemned without any reference to the condition of the flesh. It is only rarely that the flesh from such cows would not be condemned on other grounds, and taking into consideration the small number of cows in which there could be any doubt and the expense entailed in subjecting the surface of such meat to the action of boiling water, before it should, under any circumstances, be allowed to be removed from the slaughter-house, it seems to me to be advisable, considering the great danger that must always accompany the use of such meat, to strongly recommend the complete destruction of these carcases.

59 Taking into consideration also the fact that Koch's tuberculin had been injected into the only two animals in which a trace of tubercle was found in the muscles, I fully agree with Dr. Martin that any animal in which tuberculin has been used for diagnostic purposes during life, if found to be suffering from tuberculosis after death, should not be utilised for food, but should be rigorously condemned and destroyed.

Parts and organs near tubercular lesions should be condemned.

60 It may be laid down as a general rule that no part of the flesh of an animal near which there is even a localised tubercular lesion, whether in an organ, a gland, or a membrane, should be passed as food fit for immediate consumption. On this ground I am of opinion that where it is found that several glands in various parts of the body and widely separated are distinctly affected, the carcase, except in very rare cases, should be condemned as unfit for human food, and although when only one cavity, or the organs of one cavity are the sole parts affected, the bulk of a carcase may be passed, no parts over which the serous membrane is tubercular should ever be passed.

61 It would be advisable to give inspectors instructions that when the organs not usually affected, except in generalised tuberculosis (such as the popliteal, lumbar, and axillary glands) are affected, and there is any doubt in his mind as to whether the carcase is fit for human food or not he should condemn the carcase rather than give it the benefit of the doubt.

The following gives in tabular form the cases in which the three most important of these were affected.

TABLE V.

—	Lumbar glands.	Kidney.	Udder.
Mild tuberculosis, 5 cows.	2 **Tubercular.** 2 normal. 1 not examined.	—	—
Moderate tuberculosis, 4 cows.	1 **Tubercular.** 3 normal.	—	—
Advanced and generalised tuberculosis, 8 cows.	4 **Tubercular.** 2 normal. 2 not examined.	4 **Tubercular.** 4 normal.	4 **Tubercular.** 4 normal.
17 cows -	7 **Tubercular.** 7 normal. 3 not examined.	4 **Tubercular.** 4 normal.	4 **Tubercular.** 4 normal.

Practical Recommendations.

Ante-morte spectic cows.

Separa abatto tuberc cows.

Inspec before during dressi

Dressi knives placed boilin water.

All pa and o must exami

Dispo conde carca

Prolo boilin

62 Coming now to the practical outcome of information gathered from the tabulated experiments with raw and cooked meats, I should recommend that every animal be inspected before it is killed by a veterinary surgeon working in conjunction with the medical officer of health; that wherever on such examination the presence of tuberculosis is suspected, the animal should be taken to a separate abattoir kept for the purpose; that no animals should be slaughtered in any but licensed slaughter-houses, and should there be killed and dressed by men specially instructed for such work; that if in the general work of the abattoir, any tubercular lesions are found in an animal, the chief inspector should be immediately called before the process of dressing is continued, and that he should order the animal to be taken to the special department for the cutting up of such animals, and that he shall there direct what is to be done with the affected carcase; that from such carcases as are not totally condemned the affected parts should be cut out whole before the meat is further dressed, and that such dressing should be carried on with knives from time to time placed in boiling water; that in order to ensure efficient inspection of the organs and parts of an animal affected with tuberculosis, all animals should be condemned where any attempt has been made to hide the presence of disease by stripping off the pleura or peritoneum, especially where the organs have not been kept for examination, and where the glands have been removed before the inspector has been called to examine the carcase. It is unnecessary to say that all organs and parts condemned should be thoroughly sterilised or destroyed out and out, and that even when sterilised should not be allowed to be used for food of any kind. As, however, boiling destroys the virulence of tubercle bacilli it may be suggested that arrangements might be made for extracting the fat and gelatine by means of this process (or by the use of superheated steam) from condemned material, after which extraction the remainder of the material might be used for manure or treated by distillation.

Plun meat tube cows by th spect

63 As our experiments with plunged meat gave only one positive result I should recommend that in those cases where part of the carcase only is condemned the remainder should be plunged in boiling water for 5 or 10 minutes; this would not in any way interfere with the nutritive value of the meat; it would have the additional advantage of sterilising absolutely the outer portion of the meat through which as our experience shows the meat would keep in a sweet condition for a longer time than if left unplunged, and it would naturally do away with the danger to be apprehended from ordinary accidental contamination of other meat. It would be a guarantee equal to a stamp mark that the inspector considers it suitable for human food when so treated, and would, in consequence, enhance the value of what in Germany is looked upon as very inferior meat.

Part III.

Report on Feeding and Inoculation Experiments with Meat from Tuberculous Cows.

(*a*) Boiled.
(*b*.) Roasted as for use at the table.

Object of the Investigation.

64 This part of the investigation was carried out for the purpose of determining whether boiling and roasting the meat from tuberculous cows would render it innocuous, when used for feeding, and secondly to determine by inoculation experiments whether the tubercular virus, although rendered incapable of producing tuberculosis through feeding, still retained its power of acting on the unprotected tissues when introduced into them by means of inoculation.

In the first instance, as we have seen, it was necessary to determine whether the flesh from tuberculous animals had any infective power when it was inoculated into, or ingested by, pigs, guinea-pigs, or cats. As these control experiments necessarily occupied a considerable time, and as it was necessary to use the flesh from the same animals in both cooking and control experiments, it was evident that the cooking experiments must be carried on at the same time as the controls.

If the controls should give negative results the cooking experiments would of course lose much of their value, unless the results obtained by Dr. Martin, which could be drawn from a much larger number of cases than was possible in my experiments, gave a certain number of positive results. It has been arranged, therefore, that in all cases where the meat and milk used in connection with Inquiries II. and III. have been obtained from the same tuberculous cows, the animals inoculated and fed with such raw meat or milk should be used as controls for the other feeding experiments.

The actual temperature attained in the meat was determined either by means of thermometers or by fusible metal (of various melting points) placed at different distances from the surface of the joint (*see* Tables XV to XXI).

As it was essential to determine whether meat as ordinarily sent to the table was capable, when taken from tuberculous cows, of producing tuberculosis either by feeding or inoculation, we took the precaution to carry out our cooking experiments in the same fashion as cooking is done in the kitchen.

Boiling.

65 In the boiling experiments, the meat was simply put into boiling water in a tin vessel, in most cases covered with a lid in order that the whole of the meat might be exposed to water or steam at boiling point, great care being taken to keep the water constantly boiling, over a large Bunsen burner. The ordinary rule adopted by the housewife of giving a quarter of an hour's boiling for each pound of meat was usually adhered to, as will be seen from the table; variations, however, were made on both sides of this limit.

Experiments were made with the meat from 11 cows, 10 of which were used for feeding experiments; 2 for both feeding and inoculation experiments, and one for inoculation experiments only. A number of control experiments were made, and these have been supplemented by those carried out by Dr. Martin; I have therefore added the whole of the control animals together in comparing the results obtained from the boiled and unboiled meat (Table No. VIII.)

Explanation of Table VI.

66 Both feeding and inoculation experiments are considered in the same table (No. VI.), and of each series the control experiments are given, each set in line with the main experiment. The first column of the table gives the number of the cow (the post mortem examination and extent of affection of which is given in Part X., p. 181 *et seq.*); the second column refers to the portion of the animal used, the buttock, or rump, muscles from the walls of the thorax or ribs, (*i.e.*, intercostal muscles), shoulder and flank; in the third column the size or the weight of the joint is given, in order that the proportion of the weight to the time that the meat is cooked may be calculated. These three columns refer to the whole of the table. The fourth column gives the time that each joint was subjected to boiling; it does not refer to the control experiments, all of which were made with raw meat; the fifth column indicates the number of animals in each feeding experiment; the sixth column the weight of meat taken by each group of animals; in the seventh column is given the number of animals that survived the feeding more than 28 days, and only this number was taken as giving any guide to the conditions resulting; then in the eighth column the net results are given, in this case every one being negative, is represented by "nil"; columns nine and ten are devoted to the control feeding experiments; in the former is indicated the number of animals fed, and in the latter the results are given, "nil" or "tubercular" as the case may be. These are followed by similar columns under the heading "inoculation experiments." At the foot of each column the general results are given.

Summary of Results.

67 The results of these experiments may be summed up very briefly.

Of 56 animals (all guinea pigs) fed with boiled meat from 10 cows not one developed the slightest trace of tuberculosis, but it must be observed that of 31 control animals fed with meat from the same cows, every one remained perfectly healthy, while Dr. Martin, carrying on a similar series of experiments with raw meat, obtained only one positive result out of 24 animals fed.

In the inoculation series (a comparatively small one) only 6 guinea pigs were inoculated with boiled meat taken from 3 cows; 3 died before the tubercle, if present, had time to manifest itself, and the other 3 were unaffected, whilst of 6 control guinea pigs inoculated with raw meat, 2 died too early to be taken account of, 3 were unaffected, and one was tubercular, viz., that inoculated with flesh from Cow No. 32. Dr. Martin, carrying on a similar series of experiments with raw meat, obtained positive results in 4 animals out of 17 (from cows 6, 13 and 22.)

Roasting.

Explanatio
of Table VI

68 We may put exactly the same interpretation, and give the same explanation of Table No. VII., in which the roasting experiments are recorded, the only difference being that the meat was, in most instances, exposed to the heating process for 20 minutes per pound weight instead of for 15 minutes, as in the case of the boiling experiments.

Rule as to time required for cooking.

Feeding ex
periments: roasted meat.

Here it will be noted that the meat from 12 cows was used after it had been roasted; 48 animals were fed on this meat, but not one developed tuberculosis. There were 34 control animals fed on raw meat from the same cows, and here again not a single one developed tuberculosis. Dr. Martin, however, feeding 26 animals, obtained positive results in three of them.

Inoculation experiments: roasted meat

Coming, now, to inoculations of roasted meat from 3 cows, Nos. 15, 23, and 30; of 7 guinea-pigs experimented on, not one developed tuberculosis, and 7 control guinea-pigs inoculated with raw meat all escaped infection. But of Dr. Martin's 15 inoculations with raw meat from the same cows, 4 contracted tuberculosis.

The comparatively large number of positive results obtained in Dr. Martin's series of experiments indicates beyond possibility of doubt the presence of infective material in the meat as it was sent out from the slaughter houses, and shows that extreme care is necessary in the after treatment of the meat in order to render it innocuous, for it must be borne in mind that we have to guard against affecting not only healthy individuals, but those, both children and adults, suffering from catarrhal or other affection—disease or injury—of the alimentary tract, in which the mucous surfaces are so altered that any tubercular material applied to them bears much the same relation to them that inoculated material bears to the unprotected tissues into which it is introduced. It is for this reason that throughout these experiments such stress is laid on the absolute necessity of determining not only whether the tubercular material was capable of infecting a healthy animal through feeding, but also whether it remained, though with its virulence diminished, sufficiently active to produce tuberculosis by means of inoculation.

The results in this series of experiments are so very simple that it is not necessary to do more than set out the results obtained from boiling and roasting in tabular form, giving the raw meat experiments as controls in the following very interesting tables (Nos. VI., VII. and VIII).

69 TABLE VI.

Cooking Experiments with Meat from Tuberculous Cows.

BOILING.

No. of Cow. — Parts affected.	Portion of Carcase used.	Size, and Weight of Joint in Grammes and Lbs.	Time Boiled.	FEEDING EXPERIMENTS.						SUBCUTANEOUS INOCULATION EXPERIMENTS.					
				No. of Animals used in each Experiment.	Amount of Meat eaten in Grammes and Lbs.	Result in Animals that lived more than 28 Days.		**Control Experiments with Raw Meat.**		No. of Animals used in each Experiment.	Material used.	Result in Animals that lived more than 21 Days.		**Control Experiments with Raw Meat.**	
						No. of Animals.	Result.	No. of Animals.	Results.			No. of Animals.	Result.	No. of Animals.	Result.
1	Meat from ribs (stripped) *i.e.*, pleura removed.	2 kilos 380 grammes (5 lbs. 3 ozs.) chiefly bone.	1 hour.	6 guinea-pigs.	450 grammes. (1 lb.)	6	Nil.	5 guinea pigs.	Nil. Dr. Martin.	..	..	..	..	2 guinea-pigs.	Nil. Dr. Martin.
6	Meat from ribs, *i.e.*, intercostal muscles.	Chiefly bone not weighed.	1 hour.	4 guinea-pigs.	600 grammes. (1 lb. 5 ozs.)	3	Nil.	1 cat. 1 kitten. 4 guinea-pigs.	Nil. Nil. Nil.	..	..	..	..	2 guinea-pigs. (Dr. Martin.)	**1 tubercular.** 1 Nil.
11	Rump.	1 kilo 800 grammes. (3 lbs. 15 ozs.)	40 minutes.	6 guinea-pigs.	500 grammes. (1 lb. 1½ ozs.)	6	Nil.	5 guinea-pigs.	Nil. Dr. Martin.	..	..	..	..	2 guinea-pigs.	Nil. Dr. Martin.
	Meat from ribs.	1 kilo 800 grammes (3 lbs. 15 ozs.) chiefly bone.	1 hour.	6 guinea-pigs.	500 grammes. (1 lb. 1½ ozs.)	6									
12	Foreleg.	Chiefly bone not weighed.	30 minutes.	3 guinea-pigs.	150 grammes. (5¼ ozs.)	2	Nil.	3 guinea-pigs.	Nil.	..	..	..	..	3 guinea-pigs.	Nil.
13	Rump.	1 kilo 300 grammes. (2 lbs. 13½ ozs.)	50 minutes.	3 guinea-pigs.	170 grammes. (6 ozs.)	3	Nil.	2 guinea-pigs.	Nil Dr. Martin.	..	..	..	..	2 rabbits. (Dr. Martin.)	**1 tubercular.** 1 Nil.
15	Rump.	1 kilo. (2 lbs. 3 ozs.)	40 minutes.	6 guinea-pigs.	600 grammes. (1 lb. 5 ozs.)	5	Nil.	12 guinea-pigs.	Nil.	2 guinea-pigs.	Meat.	1	Nil.	2 guinea-pigs.	Died too early.
16	Rump.	3 kilos. (6 lbs. 9 ozs.)	1 hour.	6 guinea-pigs.	800 grammes. (1 lb. 12 ozs.)	6	Nil.	4 guinea-pigs. (Dr. Martin.)	Nil.	1 guinea-pig.	Meat.	1	Nil.	2 guinea-pigs. (Dr. Martin.)	Nil.
20	Buttock.	..	45 minutes.	8 guinea-pigs.	400 grammes. (14 ozs.)	8	Nil.	4 guinea-pigs.	Nil.						
22	Meat from ribs, *i.e.*, intercostal muscles with pleura attached.	Chiefly bone not weighed.	40 minutes.	5 guinea-pigs.	510 grammes. (1 lb. 1¾ ozs.)	5	Nil.	6 guinea-pigs. 7 guinea-pigs. 1 pig. (Dr. Martin).	Nil. 6 Nil. **1 tubercular.** Nil.	..	..	..	..	7 guinea-pigs. (Dr. Martin.)	**2 tubercular.** 5 Nil.
29	Loin.	1 kilo 500 grammes. (3 lbs. 4½ ozs.)	40 minutes.	6 guinea-pigs.	450 grammes. (1 lb.)	6	Nil.	..	..	..	..	..	..	..	..
32	Flank.	..	45 minutes. No feeding experiments.	..	..	..	..	..	..	3 guinea-pigs.	Meat.	1	Nil.	1 guinea-pig.	**1 tubercular.**
General result, 11 cows.	..	..	..	..	..	**56 animals fed.**	**None developed tuberculosis.**	**31 control animals fed.** In Dr. Martin's series. 24 control animals fed.	**None developed tuberculosis.** 1 developed tuberculosis.	..	..	**3 animals inoculated.**	**None developed tuberculosis.**	**4 control animals inoculated.** In Dr. Martin's series. 17 control animals inoculated.	**1 developed tuberculosis.** 4 developed tuberculosis.

70 TABLE VII.

Cooking Experiments with Meat from Tuberculous Cows.

ROASTING.

No. of Cow. — Parts affected.	Portion of Carcase used.	Size and Weight of Joint in Grammes and Lbs.	**Time Roasted.**	Feeding Experiments.						Subcutaneous Inoculation Experiments.					
				No. of Animals used in each Experiment.	Amount of Meat eaten in Grammes and Lbs.	Result in Animals that lived more than 28 Days.		**Control Experiments with Raw Meat.**		No. of Animals used in each Experiment.	Material used.	Result in Animals that lived more than 21 Days.		**Control Experiments with Raw Meat.**	
						No. of Animals.	Result.	No. of Animals.	Result.			No. of Animals.	Result.	No. of Animals.	Result.
1	Ribs.	5½ kilos. Chiefly bone. (12 lbs. ½ oz.)	2 hours.	6 guinea-pigs.	450 grammes. (1 lb.)	6	Nil.	5 guinea-pigs. (Dr. Martin.)	Nil.	..	..	..	..	2 guinea-pigs. (Dr. Martin.)	Nil.
6	Rump.	6 kilos. (13 lbs. 2 ozs.)	2½ hours.	4 guinea-pigs.	600 grammes. (1 lb. 5 ozs.)	3	Nil.	1 cat. 1 kitten. 8 guinea-pigs.	Nil. Nil. Nil.	..	..	..	..	2 guinea-pigs. (Dr. Martin.)	**1 tubercular.** 1 Nil.
11	Ribs.	2¼ kilos. (4 lbs. 15 ozs.)	1¼ hours.	4 guinea-pigs.	500 grammes. (1 lb. 1½ oz.)	4	Nil.	5 guinea-pigs. (Dr. Martin.)	Nil.	..	..	..	..	2 guinea-pigs. (Dr. Martin.)	Nil.
12	Shoulder.	Chiefly bone. 3 kilos. (6 lbs. 9 ozs.)	1 hour.	3 guinea-pigs.	200 grammes. (7 ozs.)	2	Nil.	3 guinea-pigs.	Nil.	..	..	..	..	3 guinea-pigs.	Nil.
	Shoulder.	4½ kilos. (9 lbs. 13½ ozs.)	2 hours.	3 guinea-pigs.	200 grammes. (7 ozs.)	2	Nil.								
13	Rump.	2 kilos 600 grammes. (5 lbs. 11 ozs.)	2 hours 20 minutes.	3 guinea-pigs.	170 grammes. (6 ozs.)	3	Nil.	2 guinea-pigs. (Dr. Martin.)	Nil.	..	..	..	..	2 rabbits. (Dr. Martin.)	**1 tubercular.** 1 Nil.
15	Rump.	4½ kilos. (9 lbs. 13½ ozs.)	2½ hours.	6 guinea-pigs.	600 grammes. (1 lb. 5 ozs.)	4	Nil.	12 guinea pigs.	Nil.	2 guinea-pigs.	Meat.	2	Nil.	2 guinea-pigs.	Nil.
21	Rump.	3 kilos. (6 lbs. 9 ozs.)	1½ hours.	**1 pig.**	680 grammes. (1 lb. 8 ozs.)	1	Nil.	4 guinea-pigs. 2 pigs. (Dr. Martin.)	**1 tubercular.** 3 Nil. 1 Nil. **1 tubercular.**	..	..	..	..	1 guinea-pig.	1 Nil.
22	Ribs.	Chiefly bone. Not weighed.	1¼ hours.	6 guinea-pigs.	500 grammes. (1 lb. 1½ ozs.)	4	Nil.	6 guinea-pigs. 7 guinea-pigs. 1 pig. (Dr. Martin.)	Nil. **1 tubercular.** 6 Nil. Nil.	..	..	..	..	7 guinea-pigs. (Dr. Martin.)	**2 tubercular.** 5 Nil.
23	Rump.	6 kilos. (13 lbs. 2 ozs.)	3 hours.	3 guinea-pigs.	300 grammes. (10½ ozs.)	3	Nil.	3 guinea-pigs.	Nil.	3 guinea-pigs.	Meat.	3	Nil.	1 guinea-pig.	Nil.
29	Rump.	2 kilos 300 grammes. (5 lbs. ½ oz.)	1 hour 10 minutes.	6 guinea-pigs.	450 grammes. (1 lb.)	6	Nil.	..	..	..	..	..	..	..	..
30	Rump.	3 kilos 900 grammes. (8 lbs. 8½ ozs.)	2 hours.	6 guinea-pigs.	440 grammes. (15½ ozs.)	6	Nil.	..	..	2 guinea-pigs.	Meat.	2	Nil.	..	..
31	Rump.	3 kilos 580 grammes. (7 lbs. 13½ ozs.)	3 hours.	6 guinea-pigs.	440 grammes. (15½ ozs.)	4	Nil.	..	..	..	..	..	..	..	..
General results. 12 cows.	..	..	..	..	..	**48 animals fed.**	**None developed tuberculosis.**	**34 control animals fed.** In Dr. Martin's series: 26 control animals fed.	**None developed tuberculosis.** 3 developed tuberculosis.	..	..	**7 animals inoculated.**	**None developed tuberculosis.**	**7 control animals inoculated.** In Dr. Martin's series: 15 control animals inoculated.	**None developed tuberculosis.** 4 developed tuberculosis.

TABLE VIII.

71 Summary of Results contained in the two foregoing Tables. The Controls include both Dr. Martin's experiments and my own.

——	Inoculated.	Result.	Fed.	Result.
Boiled meat from 11 cows	3	Nil.	56	Nil.
Raw meat from 10 cows (controls).	21	**5 tub.**	55	**1 tub.**
Roasted meat from 12 cows	7	Nil.	48	Nil.
Raw meat from 9 cows (controls).	22	**4 tub.**	60	**3 tub.**
Cooked meat from 15 cows	10	Nil.	104	Nil.
Raw meat from 12 cows (controls).	43	**9 tub.**	115	**4 tub.**

From this table it will be seen that of 114 animals fed or inoculated with meat subjected to cooking, by boiling or roasting, taken from 15 cows, not a single one contracted tuberculosis. Meat from the same animals was not always used in both boiling and roasting experiments.

Whilst of 158 animals treated in a similar manner with raw meat from the same cows, 13 became tubercular.

As has already been pointed out, the positive results were obtained almost entirely from cows in an advanced and generalised stage of the disease.

It will be noticed that the per-centage of positive results obtained by inoculation experiments were to those obtained by feeding as 20·9 to 3·47.

Part IV.

Report on Feeding and Inoculation Experiments (with Controls) with manifestly Tuberculous Material—Glands, Lung, Udder, &c.

(*a.*) Boiled. (*b.*) Roasted.

Object of the Investigation.

72 Having determined the nature and degree of the danger to be anticipated from the use of tuberculous meat, and taking into consideration the fact that under certain conditions tubercular glands might accidentally be left in the joints of meat, or that tuberculous material might be carried in by the butchers' knife during the process of cutting up the meat, taken from tuberculous animals, it was considered necessary to find out the degree and nature of the danger arising from the use of tuberculous material, and of determining how such material of known infectivity could be rendered innocuous. As a first step towards a solution of this question, a series of cooking experiments with manifestly tubercular material—glands, lung, and udder, &c.—was carried out, of which the details will be found in Tables Nos. IX. and X., pp. 121, 122.

General Method of Procedure.

73 In this series of experiments portions of obviously tubercular organs or glands taken from 9 cows and 1 phthisical lung (in all of which tubercle bacilli were easily demonstrated) were used as material for feeding and inoculation after they had been subjected to boiling or roasting. The same arrangement of the tables is observed as is given in connexion with the previous set of cooking experiments.

Boiling.

74 Of 41 animals (40 guinea-pigs and 1 pig) fed on obviously tubercular material, that had been subjected to boiling, obtained from 8 tubercular cows and 1 tubercular human lung, only 4 developed tuberculosis, whilst of 18 animals (1 pig and 17 guinea-pigs) fed on raw material from the same source, 14 developed tuberculosis. In all these cases where positive results were obtained the material had been cooked for a shorter time than that allowed by cooks in the kitchen. In each case the infective material was lung, which is exceedingly voluminous in proportion to its weight; in addition to this the caseous material which it contained was somewhat deeply embedded in its substance, and was surrounded by a dense fibrous capsule. The slices of udder and glands, and even some pieces of lung subjected to boiling for a longer time were invariably non-infective.

In the inoculation experiments with boiled tuberculous material, only 2 out of 16 guinea-pigs became tuberculous, one infected with material from a thin slice of the udder of Cow No. 9, the other from a piece of caseous tubercle from the lung of Cow No. 19. The control inoculations gave 11 positive results out of 12 animals experimented on.

TABLE IX.

Cooking Experiments with Manifestly Tuberculous Material.

BOILING.

Material used.	Portion of Carcase or Organ used.	Size, and Weight in Grammes and Lbs.	**Time Boiled.**	Feeding Experiments.						Injection and Inoculation Experiments.					
						Result in Animals that lived more than 28 Days.		**Control Experiments with Raw Material.**				Result in Animals that lived more than 21 Days.		**Control Experiments with Raw Material.**	
				No. of Animals used in each Experiment.	Amount in Grammes and Lbs. of Meat Eaten.	No. of Animals.	Result.	No. of Animals.	Result.	No. of Animals used in each Experiment.	Solid Material or Emulsion.	No. of Animals.	Result.	No. of Animals.	Result.
Cow 1	Ribs with grapes attached.	Chiefly bone.	1 hour.	6 guinea-pigs.	450 grammes (1 lb.)	6	Nil.	2 guinea-pigs.	Nil.	2 guinea-pigs.	Piece boiled **only ½ hour** subcutaneous.	2	Nil.	2 guinea-pigs.	**2 Tubercular.**
										2 guinea-pigs.	Emulsion intra-peritoneal.	2	Nil.	2 guinea-pigs.	**2 Tubercular.**
	Lung.	50 grammes. (1¾ oz.)	15 minutes.	3 guinea-pigs.	30 grammes (1 oz.)	3	Nil.	..	..	..	..	..	..	..	..
Cow 9	Udder.	Slices about ½ in. thick.	5 minutes.	2 guinea-pigs.	500 grammes (1 lb. 1½ oz.)	2	Nil.	..	..	1 guinea-pig.	Piece udder.	1	**1 Tubercular**	1 guinea-pig.	**1 Tubercular**
Cow 15	Lung.	1 kilo (2 lbs. 3 ozs.)	40 minutes.	6 guinea-pigs.	600 grammes (1 lb. 5 ozs.)	4	Nil	..	..	2 guinea-pigs.	Piece lung.		Nil.	..	..
Cow 16	Lung.	2 kilos. (4 lbs. 6 ozs.)	1 hour.	6 guinea-pigs.	600 grammes (1 lb. 5 ozs.)	5	Nil.	5 guinea-pigs.	**3 Tubercular.** 2 Nil.	1 guinea-pig.	Piece lung.	1	Nil.	1 guinea-pig (inoculated with piece of lung normal to naked eye.)	Nil.
Cow 19	Lung.	½ kilo. (1 lb. 1½ oz.)	5 minutes.	3 guinea-pigs.	250 grammes (9 ozs.)	3	**1 Tubercular.** 2 Nil.	..	..	1 guinea-pig.	Piece lung, young tubercle.	1	Nil.	..	..
										1 guinea-pig.	Caseous tubercle.	1	**1 Tubercular**	..	..
Cow 21	Lung.	2½ kilos. (5 lbs. 7½ ozs.)	50 minutes.	**1 pig.**	600 grammes (1 lb. 5 ozs.)	1	**1 Tubercular.**	**1 pig.**	**1 Tubercular.**	..	..	..	..	..	..
				6 guinea-pigs.	300 grammes (10½ ozs.)	5	**2 Tubercular.** 3 Nil.	5 guinea-pigs.	**5 Tubercular.**	..	..	..	..	..	..
Cow 22	Lung.	1 kilo. 500 grammes. (3 lbs. 4½ ozs.)	1 hour.	6 guinea-pigs.	500 grammes (1 lb. 1½ oz.)	6	Nil.	5 guinea-pigs.	**5 Tubercular.**	..	..	..	..	..	..
Cow 29	Gland.	150 grammes. (5¼ ozs.)	20 minutes.	2 guinea-pigs.	150 grammes (5¼ ozs.)	2	Nil.	..	..	2 guinea-pigs.	Piece subcutaneously	2	Nil.	2 guinea-pigs.	**2 Tubercular.**
										2 guinea-pigs.	Emulsion intra-peritoneally.	2	Nil.	2 guinea-pigs.	**2 Tubercular.**
Human lung.	Human lung.	½ kilo. (1 lb. 1½ oz.)	20 minutes.	4 guinea-pigs.	200 grammes (7 ozs.)	4	Nil.	..	..	2 guinea-pigs.	Piece lung.	2	Nil.	2 guinea-pigs.	**2 Tubercular.**
General result, 8 cows. 1 Human Lnng.	..	..	..	..	..	**41 animals fed.**	**4 developed tuberculosis.**	**18 control animals fed.**	**14 developed tuberculosis.**	..	..	**16 animals inoculated.**	**2 Tubercular.**	**12 control animals inoculated.**	**11 developed tuberculosis.**

TABLE X.

Cooking Experiments with Manifestly Tuberculous Material.

ROASTING.

Material used.	Portion of Carcase or Organ used.	Size and Weight in Grammes and Lbs.	**Time Roasted.**	Feeding Experiments.						Injection and Inoculation Experiments.					
				No. of Animals used in each Experiment.	Amount in Grammes and Lbs. of Meat Eaten.	Result in Animals that lived more than 28 Days.		**Control Experiments with Raw Material.**		No. of Animals used in each Experiment.	Solid Material or Emulsion.	Result in Animals that lived more than 21 Days.		**Control Experiments with Raw Material.**	
						No. of Animals.	Result.	No. of Animals.	Result.			No. of Animals.	Result.	No. of Animals.	Result.
Cow 22	Gland	470 grammes (16½ ozs.)	1 hour.	6 guinea-pigs.	470 grammes (16½ ozs.)	4	**3 Tubercular** 1 Nil.	3 guinea-pigs.	**2 Tubercular.** 1 Nil	..	..	..	..	..	..
Cow 23	Lung	1¼ kilos. (2 lbs. 12 ozs.)	2½ hours.	1 cat.	300 grammes (10½ ozs.)	1	Nil.	..	..	1 cat.	Piece lung.	1	Nil.	..	..
General result, 2 cows.	..	..	..	..	..	**5 animals fed.**	**3 developed tuberculosis.**	**3 control animals fed.**	**2 Tubercular.**	..	..	**1 cat inoculated.**	**Did not develop tuberculosis.**	..	..

Roasting.

75 Of the two sets of experiments made with roasted tubercular material taken from 2 cows in an advanced stage of disease, 3 guinea-pigs, out of 5 animals fed, developed tuberculosis, whilst of 3 animals fed with raw material of a similar nature and from the same cows, 2 became tubercular. Gene result

It should be noted in this connexion that raw tuberculous glands contained the most virulent material that was ever obtained by us in solid form; when roasted this material still remained infective. Material from tuberculous lungs also, though not giving the same number of positive results when ingested or inoculated raw, could not easily be rendered innocuous by cooking. In this series there was only one case in which the lung was roasted. The roasted lung proved non-infective both as regards feeding and inoculation. 11 out of 12 control guinea-pigs inoculated with the raw tuberculous material from the same sources developed tuberculosis at an early date.

Summary of Results.

76 Put into tabular form, (Table No. XI.), we obtain the following survey of these experiments. Out of 63 animals fed or inoculated with cooked tubercular material of various kinds only 9 or 14·2 per cent. became tubercular. Of those inoculated, 2 out of 17 or 11·7 per cent. became tubercular, whilst of the animals fed, 7 out of 46 or 15·2 per cent. became tubercular.

When raw tubercular material from the same sources was used for feeding and inoculation, 27 animals out of 33 or nearly 81·8 were affected. Of the inoculated animals, 11 out of 12 animals or 91·6 per cent. succumbed to tuberculosis, whilst of the animals fed, 16 out of 21 or 76·1 per cent. were attacked.

TABLE XI.

——	Inoculated.	Result.	Fed.	Result.
Roasted tubercular glands, lung, &c., from 2 cows.	1	Nil.	5	**3 tubercular.**
Raw tubercular glands from 1 cow.	—	—	3	**2 tubercular.**
Boiled glands, lung, &c., 8 cows and 1 human being.	16	**2 tubercular.**	41	**4 tubercular.**
Raw glands, lung, &c., 6 cows and 1 human lung.	12	**11 tubercular**	18	**14 tubercular.**
General results with cooked tuberculous material.	17	**2 tubercular.**	46	**7 tubercular.**
General results with raw tuberculous material.	12	**11 tubercular.**	21	**16 tubercular.**

Conclusions.

77 The two chief points brought out by this table are that where obviously tubercular material (that is material containing a considerable number of tubercle bacilli, of course in a virulent form) is used, not only is the percentage of the animals affected in both feeding and inoculation experiments large, but the percentages of positive results obtained by these methods approximate much more closely than when the active infective agent is present in smaller numbers or quantities; this, of course, is what one would expect, as the extreme limit of infectivity is more and more nearly approached. Dedu from result

The second point is that the most deadly tubercular material can be rendered absolutely innocuous so far as any spreading infective disease is concerned by the action of a temperature at which water boils. We have evidence, *see* Part XII. and XIII. (Milk), pp. 221 *et seq.*, that a lower temperature than this is sufficient to bring about the same results when allowed to act for a longer time but, for the present, it is sufficient to state that boiling for an instant, even, renders the tubercle bacillus absolutely innocuous; it must be borne in mind, however, and we have ample evidence of this in the experiments before us, that each separate part of the tuberculous material must be subjected to the direct action of the boiling temperature in order that its activity may be completely destroyed, for, as in the case of the slices of udder from Cow No. 9 half an inch thick, subjected to five minutes boiling, the central portion, though no longer capable of producing tuberculosis when taken into the alimentary canal of a guinea-pig, was still capable of setting up the disease when inoculated into the subcutaneous tissues, whilst in the case of Cow 21 the lung, boiled for 50 minutes only, still remained infective, in a remarkable degree, even when used for feeding purposes.

PART V.

Report on Feeding and Inoculation Experiments (with Controls) with Meat rendered Infective by the Addition of Obviously Tubercular Material.

(*a*.) Boiled; (*b*.) Roasted.

Object of the Investigation.

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78 These experiments were carried out for the purpose of ascertaining what would be the fate of obviously tubercular material present in the substance of meat during the process of cooking.

It has already been proved that tuberculous material accidentally smeared on the outside of a joint is readily rendered innocuous, in most cases, at any rate, by plunging the joint into boiling water for a few minutes, and of course also by the process of cooking to which meat is usually subjected before it is served up for consumption. It is well known, however, that meat, especially second-class meat, is, before it leaves the hand of the butcher, often made into rolls which are firmly bound with string and are cooked without being again undone. Tubercular matter may thus be contained within the roll where it is well protected from the action of a high temperature unless the exposure of the meat to the action of heat be continued for a very prolonged period. When meat is salted it is also often treated in this same way. There has also been pointed out the possibility of the accidental presence of tubercular glands in what is apparently otherwise healthy and sound meat.*

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The thin muscles of the wall of the abdomen which lie immediately under the peritoneum, so frequently affected by tuberculosis, are just those which are most readily made into rolls, and as the danger of infective material still remaining adherent in such cases is very considerable, it was thought necessary to determine the infectivity of meat intentionally contaminated and then cooked.

Method of Procedure.

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79 The experiments made were of two kinds. In the larger number of these experiments a piece of sirloin was obtained from a local butcher; from this sirloin the butcher was requested to remove the bone. It was then cut into a strip of from 18 inches to 24 inches long and varying in thickness from 1 inch to 1½ inches; this was laid out on a table and small incisions were made over the whole of the upper surface. An emulsion of obviously tubercular material was prepared by grinding and pounding down tubercular organs from cattle, pigs or guinea-pigs, mixing this with milk and passing the mixture through a fine sieve, the part kept back being again ground and pounded until it would all pass through. This emulsion was thoroughly rubbed into the incisions and over the whole surface of the meat, which was then rolled up from one end, so that layers of finely divided tubercular material were enclosed at different distances from the surface; this roll was then firmly bound in all directions with string, so as to prevent, as far as possible, the access of boiling water between the layers.

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terial.

Time of cooking.

The prepared roll was then cooked for a period corresponding to its size, usually a quarter of an hour for each pound weight in the boiling experiments, and 20 minutes for each pound, in the roasting experiments.

Method of determining the temperature reached.

Pieces of fusible metal of different melting points were in some cases introduced along with the tuberculous material between the layers of the meat, whilst in other cases thermometers were pushed for different distances into the substance of the roll and then tied firmly in position, in order to prevent the water or fat filtering along the side of the stem of the thermometer down to the bulb.

Second method of infecting the meat used for experiment.

In a couple of experiments, one boiling and one roasting, the tuberculous material was introduced 3 inches from the nearest surface, and as near the bone as possible, by means of a glass pipette into a block of meat. The opening made by the pipette was then carefully closed by means of a slip or plug of meat, which was held in position by a pin or skewer firmly bound with string, so as to press together the opposed surfaces along the incision.

Amount of infective material used.

In both methods of infection the quantity of tuberculous material introduced was no doubt considerably greater than would probably ever be present as the result of accidental contamination, but the results as regards the action of heat on the infective material were exactly the same as would be obtained in the ordinary process of cooking, and the larger quantity was used merely in order that one might make more sure of obtaining a sufficient quantity for experimental purposes when the joint came to be opened up after it had been cooked.

Treatment of cooked infective material.

After the meat had been allowed to cool, it was carefully unrolled, the condition of the fusible metal was observed, and then portions of the smeared surfaces at different depths of the joint were removed with sterilised knives and transferred to a mortar sterilised by means of carbolic acid, spirit and boiled water. This tubercular material was then broken down with a small quantity of water, and passed, just as in the case of the preparation of the emulsion, through a metal strainer, which had been carefully sterilised in the above fashion; the fluid so obtained was used for injection into the peritoneal cavity, and it was found that the guinea-pigs bore this injection extremely well; for subcutaneous inoculation small fragments of the scrapings were carefully inserted under the skin, great care being taken that all the knives and scissors used had in the first instance been sterilised by means of heat or carbolic acid.

Injection and inoculation experiments.

Precautions taken.

Feeding experiments.

The meat used for feeding experiments was also taken from different layers, that is, at different distances from the surface of the joint. Reference to this is made in tables No. XII. and XIII., pp. 221, *et seq.* giving the general results of the experiments.

The prepared meat was kept as long as possible in sterile beakers in the ice safe, the animals being fed with small quantities twice a day, as long as the meat lasted or as long as the guinea-pigs would take it; the amounts used are also given in the tables.

As the source of the tubercular material was not of importance, we have not given this in detail.

Description of Plan of Tables XII. and XIII.

80 The first column in each table gives the number of the experiment in this series; the second column gives the nature of the material used; the third, the size in inches and weight in kilogrammes and pounds of the joint; these three columns refer to the whole table; the fourth column gives the time that the meat was subjected to boiling or roasting, roughly calculated as in the other tables in which cooking experiments are recorded, as 15 minutes per pound in the boiling experiments and 20 minutes per pound in the roasting experiments. The other columns are arranged as in the previous tables.

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* I am informed by Dr. Hamilton, Professor of Pathology in the University of Aberdeen, that on two occasions he has found a tubercular gland in the centre of a joint served at table.

TABLE XII.

Cooking Experiments with MEAT PURPOSELY CONTAMINATED with obviously Tubercular Material.—BOILING.

No. of Experiment.	Nature of Material used.	Size and Weight of Joint.	Time boiled.	Feeding Experiments.						Inoculation and Injection Experiments.					
				No. of Animals in each Experiment.	Amount of Meat eaten in Grammes and Lbs.	Result in Animals that lived more than 28 Days.		Control Experiments.		No. of Animals in each Experiment.	Meat or Emulsion.	Result in Animals that lived more than 21 Days.		Control Experiments.	
						No. of Animals.	Result.	No. of Animals.	Results.			No. of Animals.	Result.	No. of Animals.	Result.
1.	Sirloin smeared, tubercular lung of cow.	Roll, 6 inches by 6 inches.	1 hour 20 minutes.	3 guinea-pigs.	500 grammes (1 lb. 1½ ozs.) from outer and centre portion.		Nil.	3 guinea-pigs.	**2 Tubercular.** 1 Nil.	2 guinea-pigs.	Subcutaneously with piece of meat taken 3 inches from surface.	2	**Tubercular.** 1 Nil.	..	..
										2 guinea-pigs.	Do., 2 inches from surface.		**1 Tubercular.**	..	..
2.	Thigh injected 2½ inches from surface with lung and gland emulsion from cow.	Solid piece, 3 kilos 200 grammes. (7 lbs.)	1½ hours.	2 guinea-pigs.	100 grammes (3½ ozs.) from centre portion.	1	Nil.	3 guinea-pigs.	**3 Tubercular.**	2 guinea-pigs.	2 cc. emulsion, taken from centre of meat, subcutaneously.	2	**2 Tubercular.**	..	..
										2 guinea-pigs.	1 cc. emulsion of do. intraperitoneally.	2	Nil.	..	..
3.	Sirloin smeared, caseous glands and lung of cow.	Roll, 3 kilos 650 grammes. (8 lbs.)	2 hours.	1 cat.	500 grammes (1 lb. 1½ ozs.) out and inner portion.	1	Nil.	3 guinea-pigs (same controls as above.)		2 guinea-pigs.	1 cc. emulsion, taken from meat 2 inches from surface sub cutaneously.	2	**2 Tubercular.**	..	..
				3 guinea-pigs.	400 grammes (14 ozs.) from 2 inches from surface.	2	Nil.								
										2 guinea-pigs.	1 cc. emulsion of do. intraperitoneally.	..	Died too early to show tubercle.	..	..
				3 guinea-pigs.	400 grammes (14 ozs.) from 3 inches from surface.	3	Nil.			2 guinea-pigs.	1 cc. emulsion taken from meat 3 inches from surface subcutaneously.	2	**2 Tubercular.**	..	..
										2 guinea-pigs.	1 cc. emulsion of do. intraperitoneally.	1	**1 Tubercular.**	..	..

TABLE XII.—*continued.*

Cooking Experiments with MEAT PURPOSELY CONTAMINATED with obviously Tubercular Material.—BOILING.—*continued.*

No. of Experiment.	Nature of Material used.	Size and Weight of Joint.	Time boiled.	FEEDING EXPERIMENTS.						INOCULATION AND INJECTION EXPERIMENTS.					
				No. of Animals in each Experiment.	Amount of Meat eaten in Grammes and Lbs.	Result in Animals that lived more than 28 Days.		Control Experiments.		No. of Animals in each Experiments.	Meat or Emulsion.	Result in Animals that lived more than 21 Days.		Control Experiments.	
						No. of Animals.	Result.	No. of Animals.	Results.			No. of Animals.	Result.	No. of Animals.	Result.
4.	Sirloin smeared with tubercular lung of cow.	Roll, 4 kilos 700 grammes (10 lbs. 8½ ozs.)	1¾ hours.	4 guinea-pigs.	500 grammes (1 lb. 1½ ozs.) from outer and inner portion.	1	**Tubercular.**	..	..	2 guinea-pigs.	2 cc. emulsion, taken from outside and centre of meat, intraperitoneally	1	**Tubercular.**	..	..
										2 guinea-pigs.	1 cc. emulsion of do. intraperitoneally.	1	**Tubercular.**	..	..
	Sirloin smeared with tubercular lung of cow.	Roll, 4 kilos 700 grammes (10 lbs. 8½ ozs.)	1¾ hours.	**1 pig.**	5,000 grammes (10 lbs. 15 ozs.) in all from outer and centre portion.	1	**Tubercular.**	**1 pig.**	**Tubercular.**	..	..	..	..	..	..
	Piece meat smeared with tubercular lung of cow.	Roll, 3½ kilos (7 lbs 10½ ozs.)	1¾ hours.												
5.	Piece meat smeared with tubercular udder of cow.	Roll, 2 kilos 700 grammes (5 lbs. 14½ ozs.)	1¾ hours.	3 guinea-pigs.	400 grammes (14 ozs.) outer and inner portion.	3	Nil.	2 guinea-pigs.	**2 Tubercular.**	2 guinea-pigs	1 cc. emulsion, taken from outside and centre of meat subcutaneously.	2	Nil.	..	..
										2 guinea-pigs.	1 cc. emulsion, of do. intraperitoneally.	2	Nil.	..	..
General Results, 5 Experiments.	..	..	..	..	..	**15 animals fed.**	**2 developed tuberculosis.**	**9 control animals fed.**	**8 developed tuberculosis.**	..	..	**18 animals inoculated or injected.**	**11 developed tuberculosis.**	..	..

TABLE XIII.

Cooking Experiments with MEAT PURPOSELY CONTAMINATED with obviously Tuberculous Material.—ROASTING.

No. of Experiment.	Nature of Material used.	Size and Weight of Joint.	Time roasted	Feeding Experiments.						Inoculation and Injection Experiments.					
				No. of Animals in each Experiment.	Amount of Meat eaten in Grammes and Lbs.	Result in Animals that lived more than 28 Days.		Control Experiments.		No. of Animals in each Experiment.	Meat or Emulsion.	Result in Animals that lived more than 21 Days.		Control Experiments.	
						No. of Animals.	Result.	No. of Animals.	Results.			No. of Animals.	Result.	No. of Animals.	Result.
1	Flank smeared with tubercular lung of cow.	Roll, 1 kilo. (2 lbs. 3 ozs.)	4 hours.	3 guinea-pigs.	300 grammes (10½ ozs.) outer and inner portion of meat.		Nil.	3 guinea-pigs.	**3 Tubercular.**	3 guinea-pigs.	Sub-cutaneously with piece of meat from centre.	2	Nil.	..	..
	Sirloin smeared with tubercular lung of cow.	Roll, 6 inches × 6 inches, 2½ kilos. (5 lbs. 7½ ozs.)	2½ hours.	3 guinea-pigs.	500 grammes (1 lb. 1½ ozs.) outer and inner portion of meat.		Nil.	3 guinea-pigs (same controls as above).		2 guinea-pigs.	Sub-cutaneously with piece meat 3 inches from surface.	2	Nil.	..	..
										2 guinea-pigs.	Do. with piece meat 2 inches from surface.	2	Nil.	..	..
3	Piece meat smeared with tubercular lung of cow.	3 kilos 600 grammes (7 lbs. 3½ ozs.)	2 hours.	1 cat.	1,200 grammes (2 lbs. 10 ozs.) outer and inner portion.	1	Nil.	1 cat.	**1 Tubercular.**	5 guinea-pigs.	2½ cc. emulsion taken from centre of meat intraperitoneally.	..	Died too early to show tubercle.	..	..

TABLE XIII.—*continued.*

Cooking Experiments with MEAT PURPOSELY CONTAMINATED with obviously Tuberculous Material.—ROASTING.—*continued.*

No. of Experiment.	Nature of Material used.	Size and Weight of Joint.	Time roasted.	Feeding Experiments.						Inoculation and Injection Experiments.					
				No. of Animals in each Experiment.	Amount of Meat eaten in Grammes and Lbs.	Result in Animals that lived more than 28 Days.		Control Experiments.		No. of Animals in each Experiment.	Meat or Emulsion.	Result in Animals that lived more than 21 Days.		Control Experiments.	
						No. of Animals.	Result.	No. of Animals.	Result.			No. of Animals.	Result.	No. of Animals.	Results.
	Piece meat injected about 3 inches from surface with lung and glands emulsion from cow.	4 kilos. (8 lbs. 12 ozs.)	2½ hours.	2 guinea-pigs.	100 grammes (3½ ozs.) outer and inner portion.	2	Nil.	3 guinea-pigs.	**3 Tubercular.**	2 guinea-pigs.	2½ cc. emulsion taken from outer and inner portion of meat subcutaneously.	..	Died too early.	..	..
										2 guinea-pigs.	1 cc. emulsion of do. intraperitoneally.		**2 Tubercular.**	..	..
	Sirloin smeared with caseous glands and lung of cow.	Roll, 3 kilos 700 grammes. (8 lbs. 3½ ozs.)	2½ hours.	1 cat.	500 grammes (1 lb. 1½ ozs.) taken from outer and inner portion.	1	Nil.	3 guinea-pigs (same controls as above).		2 guinea-pigs.	2 cc. emulsion from outer portion of meat subcutaneously.	2	**2 Tubercular.**	..	..
				guinea-pigs.	400 grammes (14 ozs.) taken from outer portion.	3	Nil.			2 guinea-pigs.	1 cc. emulsion of do. intraperitoneally.	..	Died too early.	..	..
				3 guinea-pigs.	400 grammes (14 ozs.) taken from inner portion 3 inches from surface.	2	**1 Tubercular.** 1 Nil.			2 guinea-pigs.	2 cc. emulsion from inner portion 3 inches from surface; subcutaneously.		**2 Tubercular.**	..	..
										2 guinea-pigs.	1 cc. emulsion of do. intraperitoneally.		**Tubercular.**	..	..

TABLE XIII.—*continued.*

Cooking Experiments with MEAT PURPOSELY CONTAMINATED with obviously Tuberculous Material.—ROASTING.—*continued.*

No. of Experiment.	Nature of Material used.	Size and Weight of Joint.	Time roasted.	Feeding Experiments.						Inoculation and Injection Experiments.					
				No. of Animals in each Experiment.	Amount of Meat eaten in Grammes and Lbs.	Result in Animals that lived more than 28 Days.		Control Experiments.		No. of Animals in each Experiment.	Meat or Emulsion.	Result in Animals that lived more than 21 Days.		Control Experiments.	
						No. of Animals.	Result.	No. of Animals.	Result.			No. of Animals.	Result.	No. of Animals.	Result.
6	Sirloin smeared with tubercular lung of cow,	Roll, 10 inches × 6 inches, 4 kilos 700 grammes. (10 lbs. 4½ ozs.)	3¼ hours.	4 guinea-pigs.	300 grammes (10½ ozs.) outer and inner portion.	3	**3 Tubercular.**	..	..	2 guinea-pigs.	2 cc. emulsion from inner portion of meat subcutaneously.	2	**2 Tubercular.**	..	..
										2 guinea-pigs.	1 cc. emulsion of do. intraperitoneally.	1	**Tubercular.**	..	..
	Sirloin smeared with tubercular lung of cow.	Roll, 10 inches × 6 inches, 4 kilos 700 grammes (10 lbs. 4½ ozs.)	3¼ hours.	**1 pig.**	6,000 grammes (13 lbs. 2 ozs.) outer and inner portion.	1	**Tubercular.**	**1 pig.**	**Tubercular.**	..	..	..	..	..	..
	Meat smeared with tubercular material.	Roll, 3 kilos 150 grammes (7 lbs.)	2½ hours.												
7	Meat smeared with tubercular udder of cow.	Roll, 1 kilos 800 grammes (3 lbs. 15 ozs.)	2 hours.	3 guinea-pigs.	400 grammes (14 ozs.) outer and inner portion.	2	Nil.	2 guinea-pigs. **1 pig**	**2 Tubercular.** **Tubercular.**	2 guinea-pigs.	1 cc. emulsion from outer and inner portion of meat subcutaneously.	2	Nil.	..	..
										2 guinea-pigs.	1 cc. emulsion of do. intraperitoneally.	2	Nil.	..	..
General results, 7 Experiments.	..	..	..	..	..	**21 animals fed.**	**5 developed tuberculosis.**	**11 control animals fed.**	**10 developed tuberculosis.**	..	..	**20 animals inoculated or injected.**	**10 developed tuberculosis.**	..	..

Ordinary cooking not sufficient to destroy the bacillus tuberculosis in meat.

81 It is obvious from the results obtained from this series of experiments that the temperature attained in the centre of a roasted or boiled roll is not sufficient to render the contained tubercular material innocuous when given as food; this fact is even more strikingly accentuated when the material is used for inoculation or injection experiments.

The tubercular material with which the meat was smeared contained so many bacilli that it was deemed quite unnecessary to make any special control inoculation experiments; that this was unnecessary is evident from the fact that 90 per cent. of the animals fed with the raw material developed tuberculosis. *See* Table XIV.

Boiling.

82 The raw material used in this series of experiments being so distinctly virulent, it is interesting to find that though still dangerous, its power of giving tuberculosis when ingested in the alimentary canal had been distinctly diminished; only 2 animals out of 15, or 13·3 per cent., in the case where boiled meat had been used, contracting the disease.

Roasting.

83 In the case of the roasted meat (as in the roasting experiment with tuberculous glands and lung), the diminution in the virulence was not so great, as 5 out of 21 animals fed with this material, or 23·8 per cent. still contracted tuberculosis (Table XIV.). These figures however do not accurately represent the danger to be anticipated from the use of such material under certain conditions and in some animals, for it will be noted that when inoculation was resorted to in order to test the virulence of the cooked tubercular material, the percentage of positive results in the case of the boiled smeared meat was over 61·1 per cent., 11 guinea-pigs out of 18 succumbing to tuberculosis under these conditions, whilst somewhat curiously in the case of roasted meat, only 50 per cent., that is, 10 out of 20 guinea-pigs were affected. This apparent variation from what has usually been found in connexion with the diminution of the virulence of the tubercle bacillus when subjected to boiling or roasting is in great part explained by the fact, as will be seen on reference to Tables Nos. XII. and XIII., that a larger number of the animals experimented upon died before tuberculosis could possibly have developed when roasted meat was used for inoculation purposes than when boiled meat was used.

General Results of these Experiments.

84 The general results may be seen at a glance in Table No. XIV.

TABLE XIV.

——	Inoculated or Injected.	Result.	Fed.	Result.
Boiled Smeared Meat	18	**11 Tubercular.**	15	**2 Tubercular.**
Raw material (controls)	—	—	9	**8 Tubercular.**
Roasted smeared meat	20	**10 Tubercular.**	21	**5 Tubercular.**
Raw material (controls)	—	—	11	**10 Tubercular.**
General results with cooked smeared meat.	38	**21 Tubercular.**	36	**7 Tubercular.**
General results with raw material (controls).	—	—	20	**18 Tubercular.**

From the above figures it may be gathered that of 74 animals to which the boiled or roasted smeared meat had been given, either as food or in the form of subcutaneous inoculation or intraperitoneal injection, 28 animals, or over 37·8 per cent., developed tuberculosis; whilst of the 20 control animals fed (it was not considered necessary to make any control inoculation experiments) with the raw virulent material, 18 animals, or 90 per cent., became tubercular.

Conclusions.

85 From these experiments it is evident that if tubercular material is left adhering to the meat that is afterwards rolled (a method of dealing with meat, especially meat of inferior quality, very commonly resorted to) roasting and boiling as ordinarily carried out cannot be relied upon to destroy its infectivity. The reason for this will be gathered on reference to the results of the experiments obtained with meat into which pieces of fusible metal and thermometers had been inserted in order to determine the actual temperature attained in different parts of these joints, the temperature being in most cases very much lower than one would have expected, even in cases where the meat appears from the cook's point of view to be thoroughly cooked.

A most important deduction to be drawn from these experiments is that if the peritoneal layer investing the thin muscles of the abdomen of the cow is affected with tuberculosis, the muscular wall should invariably be confiscated and destroyed. The danger of tuberculous glands remaining in solid joints and becoming a source of infection is *comparatively* unimportant, though should such gland be present in the centre of a joint it will be readily understood that it might prove a source of very grave danger.

PART VI.

Temperature Experiments made with Fusible Metal placed in Meat that was afterwards Boiled or Roasted.

Object of the Investigation.

86 The cooking experiments, both boiling and roasting, carried on with joints over which virulent tubercular material had been purposely smeared, left no doubt in my mind that it was not possible to rely upon cooking methods as usually carried out in the kitchen to thoroughly disinfect or to render perfectly innocuous such tubercular material as might be present accidentally or artificially enclosed within the meat.

These cooking experiments are most instructive on this point. From experiments with artificially-prepared tubercular milk it has also been possible to gauge fairly accurately the conditions of temperature necessary to render tubercular material innocuous, both as regards feeding and inoculation (*see* Part IX., p. 150), so that it was now necessary to determine whether it was possible to obtain a sufficiently high temperature at various distances from the surface of the joint when it was cooked in the ordinary fashion, to justify us in saying definitely whether the tubercle bacillus would be killed or not either near the surface or toward the centre.

Reasons for using fusible metal.

87 Experiments were first carried on with fusible metal in order that the conditions under which the temperature "indicators" were placed might resemble as closely as possible those under which the tubercular material in meat is placed when exposed to the action of the temperatures attained during the process of roasting or boiling.

The pieces of fusible metal are pushed into small incisions in the joint, or placed between the layers of a roll; they are then cut off from the hot fat and the direct action of the fire or boiling water by being firmly tied in with loops of string carried round and across the incision and around the roll in all directions.

Disadvantages.

The records obtained could not, of course, be as exact, or perhaps one should say as regular, as those given when thermometers were used, and this, as was afterwards found, for two reasons; first, the melting points of the fusible metal were so arranged in series that there were intervals of 10° C. between each; in making up fusible metal, however, it is always a somewhat difficult matter first of all to obtain such a mixture of the various elements of the alloy as to give the exact melting point required; whilst it is also found that every time the metal is melted for control and other purposes its melting point becomes slightly altered. It was found, however, as a matter of fact, that wherever a thermometer and fusible metal were used together there was seldom a discrepancy of more than a couple of degrees, centigrade, between that recorded by the thermometer and that obtained with the fusible metal. In the second place, it was not always an easy matter to gauge accurately the distance from the surface of the meat at which the metal was inserted, as even in the case of solid square joints or blocks of meat taken from the "inlift," these distances could only be measured approximately, say, within a quarter of an inch; in other cases no doubt the metal might be placed at a certain distance from the surface, but it had always to be borne in mind that it was really only cut off from the action of the boiling water or the hot dripping by the distance that lay between it and the larger loose strands of inter-muscular tissue, along which, if left uncompressed by the binding string, these hot fluids might pass. This being the case, it will be readily understood that where masses and strips of meat held together only by these same loose bands had to be dealt with, the heat would necessarily have much more free access to the metal, even when the mass was more or less firmly bound together by means of sutures and string than when the more solid joints were used. As, however, these are exactly the conditions met with in actual practice, the experiments may, for our present purposes, be looked upon as being the more valuable. In the case of the rolls specially prepared, the conditions were of course much more constant, as all could be prepared in much the same way. It was found that the actual temperature attained near the surface of meat was always much more constant than when the measurements were taken at greater depths, except in the case of rolls of equal size, in which fairly constant and equal records were obtained throughout the whole series of experiments.

Temperatures obtained during the process of Cooking.

Surface infection.

88 In considering the temperatures attained in the meat during cooking, especially roasting, we may concern ourselves chiefly with the temperature which acts upon the outer part of the meat and then with that which comes into operation in the central portion. Where the meat, as usually appears to be the case, has been infected through the agency of the knife or hands of the butcher, which have come in contact with the tubercular organs of a carcase, the dangerous material will, of course, usually lie near the surface of a joint, and the temperature of greatest moment is that coming into operation on the outer surface of the meat. Where, however, the meat has been rolled, the infective material may lie in the very centre of the joint, and it is necessary to consider what would be the fate of the tubercle bacillus placed under such conditions. In addition, the fact must be recognised that miliary and even caseous tuberculosis, as has also been pointed out by Dr. Martin (in the flesh of cows) and Koch (in the muscle of swine), may occur in the muscle, and there is therefore the possibility of such, as well as tubercular glands, being present in the centre of the joints.

Infective material in centre of joint.

Smear experi ments

As already indicated, this question has been attacked from two different points of view:—

(1.) Directly, by smearing meat with tubercular material, or injecting the virus into the interior of a joint by means of a pipette (Tables XII. and XIII., p. 124 *et seq.*).

Deduc from t mome readin

(2.) Indirectly, by ascertaining the temperatures by means of thermometers and fusible metals (Tables XV. to XXVI.) which come into operation during the process of roasting and boiling, and then determining by means of sterilisation experiments what would be the effect of these temperatures acting for the same period of time on tubercular material (Part IX., p. 150 *et seq.*). It is in connexion with this indirect method of testing the possible danger incurred by the use of tubercular meat that these thermometer readings have a special interest.

The temperatures attained in comparatively large joints naturally vary very much, according to the size of the joint and the manner in which it is cooked. As the danger is obviously greater the larger the joint, comparatively large joints have chiefly been used, in order to ascertain what temperature comes into play on tubercle bacilli if present. The cooking experiments were carried out by—

A. Boiling over a large Bunsen burner in a covered pan.

B. Roasting;

(*a.*) In gas ovens;

(*b.*) In ovens heated by a coal fire;

(*c.*) In front of a coal fire.

Temperature Experiments made with Fusible Metals placed in the Meat.

Boiling.

Meth

89 In the boiling experiments in which fusible metals placed in meat were used as indicators, the water in the cooking pan was first raised to boiling point. the meat never being introduced till there was active ebullition; this occurs at about 99° C. But as the boiling was usually carried on with the lid in position, the slight increase of pressure was sufficient to bring the temperature up to at least 100° C.

Meat at on boili watei

In order that the heating might go on under the least favourable conditions, such as may actually occur in the ordinary process of boiling, the meat, as above stated, was introduced directly into the boiling water, so that a layer of coagulated albumen, which would prevent the escape of the meat juice on the one hand, and on the other would interfere with the entrance of the boiling water into the substance of the meat, might be formed at once.

TABLE XV.

Temperature Experiments with Fusible Metal (MELTING POINT 60° C.) in Meat.

Boiling.

No.	Description and Weight.	Distance of Metal from Surface.	Time boiled.	Result.	Remarks.
1	Foreleg with bone -	1 inch -	10 minutes	Not melted.	
2	Do. - -	1 inch -	30 minutes	Melted.	
3	Tubercular lung, 520 grammes (1 lb. 2 ozs.).	2 inches -	15 minutes	Do.	
4	Tubercular lung, 950 grammes (2 lbs. 2 ozs.).	2 inches -	30 minutes	Do.	
5	Meat, 3 lbs. - -	2 inches -	50 minutes	Do.	
6	Sirloin, 3,600 grammes (8 lbs.), rolled.	3 inches -	2 hours -	Plastic -	Fusible metal not yet run. Outside of meat overdone, inside underdone. This roll was smeared with tubercular material. Feeding experiments gave negative results. Inoculation experiments produced tuberculosis in guinea-pigs. *See* Part XI., Table No. XCVIII., Material 3.

TABLE XVI.

Temperature Experiments with Fusible Metal (MELTING POINT 70° C.) in Meat. Boiling.

No.	Description and Weight.	Distance of Metal from Surface.	Time boiled.	Result.	Remarks.
7	Rump, 1,210 grammes (2 lbs. 10 ozs.).	1 inch	5 minutes	Not melted.	
8	Foreleg with bone	1 inch	30 minutes	Partially melted.	
9	Meat, 3,520 grammes (7 lbs. 13 ozs.), rolled.	1½ inches	1½ hours	Plastic.	
10	Lung, 520 grammes (1 lb. 2 ozs.), (tubercular cow).	2 inches	15 minutes	Melted.	
11	Lung, 950 grammes (2 lbs. 2 ozs.), (tubercular cow).	2 inches	30 minutes	Do.	
12	Meat, 1,350 grammes (3 lbs.).	2 inches	50 minutes	Do.	
13	Sirloin, 3,600 grammes (8 lbs.), rolled.	2 inches	2 hours	Not melted	Outside of meat overdone, inside underdone, indicating that the temperature had never reached 70° C. as there was no breaking down of the haemoglobin, which takes place at from 68° C. to 70° C. This roll was smeared with tubercular material. Feeding experiments gave negative results. Inoculation produced tuberculosis in guinea-pigs. *See* Part XI., Table No. XCVIII., Material 3.
14	Rump, 1,960 grammes (4 lbs. 2½ ozs.), 6 inches × 5 inches × 8 inches.	2½ inches	10 minutes	Do.	

TABLE XVII.

Temperature Experiments with Fusible Metal (MELTING POINT 80° C.) in Meat. Boiling.

No.	Description and Weight.	Distance of Metal from Surface.	Time boiled.	Result.	Remarks.
15	Sirloin, 3,600 grammes (8 lbs.), rolled.	½ inch	2 hours	Melted	Overdone outside, underdone inside. This roll was smeared with tubercular material. Feeding experiments gave negative results. Inoculation experiments produced tuberculosis in guinea-pigs. *See* Part XI., Table No. XCVIII., Material 3.
16	Joint, 3,330 grammes (7 lbs. 4½ ozs.).	1 inch	1¼ hours	Melted and run out.	
17	Joint, 675 grammes (1½ lbs.).	1 inch	40 minutes	Outer end melted, inner end not melted.	
18	Joint, 1,350 grammes (3 lbs.).	1¼ inches	60 minutes	Melted.	
19	Meat, 3,500 grammes (7 lbs. 10½ ozs.), 6 inches × 6 inches, slit and tied up, 10 inches × 6 inches × 5 inches.	1¼ inches	1¾ hours	Do.	Well cooked. This roll was smeared with tubercular material. Tuberculosis was set up in both feeding and inoculation experiments. *See* Part XI., Table No. XCVIII., Material 4.
20	Meat, 3,520 grammes (7 lbs. 13 ozs.), rolled.	1½ inches	1½ hours	Not melted	Thermometer reading at 1½ inches from surface 68° C.
21	Lung of tubercular cow, 675 grammes (1½ lbs.).	2 inches	50 minutes	Melted.	
22	Joint, 3,150 grammes (7 lbs.).	2½ inches	50 minutes	Not melted.	

TABLE XVIII.

Temperature Experiments with Fusible Metal (MELTING POINT 90° C.) in Meat. Boiling.

No.	Description and Weight.	Distance of Metal from Surface.	Time boiled.	Result.	Remarks.
23	Meat, slit and tied, 3,500 grammes (7 lbs. 10½ ozs.), 10 inches × 6 inches × 5 inches.	1¼ inches	1¾ hours	Not melted	Well cooked. This roll was smeared with tubercular material. Tuberculosis was set up in both feeding and inoculation experiments. *See* Part XI., Table No. XCVIII., Material 4.
24	Meat, 3,520 grammes (7 lbs. 13 ozs.), rolled.	1¼ inches	1½ hours	Do.	Thermometer reading at 1¼ inches from surface 63° C.
25	Sirloin, 2,700 grammes (6 lbs.), rolled, 6 inches × 6 inches.	3 inches	1 hour 20 minutes.	Do.	This roll was smeared with tubercular material. Feeding experiments negative. Inoculation set up tuberculosis in guinea-pigs. *See* Part XI., Table No. XCVIII., Material 1.

Results obtained.

Metal melting at 60° C.

90 Taking now the different groups, we find that the fusible metal, melting at 60° C., when placed 1 inch from the surface, is not melted in 10 minutes, whilst in 30 minutes it runs; at 2 inches from the surface it is melted in a small joint in 50 minutes, whilst 3 inches from the surface, in a joint weighing 8 lbs., it has only just become plastic in 2 hours. It may be said, therefore, that in this case the temperature has never risen above 60° C. in the centre of the joint, although it must, for a considerable length of time, have been much higher nearer the surface.

Metal melting at 70° C.

A general corroboration of this is obtained from the experiments carried on with fusible metal melting at 70° C. A piece of this metal placed at 1 inch from the surface was not melted in five minutes in a small roast of 2¾ lbs.; at 1½ inches the metal was plastic in 30 minutes in a small joint, whilst it was only just plastic in 1½ hours in a larger roast (7 lbs. 13 ounces). In a small joint of 3 lbs., the same metal was melted at 2 inches from the surface in 50 minutes; whilst in a larger roll (8 lbs.) it was not melted in 2 hours, so that here we may say that the temperature never reached 70° C. in the centre of the large joints. That it just reaches 70° C. in 1½ hours at 1½ inches from the surface (No. 9), and that nearer the surface a temperature of something over 70° C. would be attained. This is borne out by the appearance of the meat.

Haemoglobin changed at 70° C.

Wherever the metal melting at 70° C. had run the red haemoglobin colour was lost, and we had simply the slight haematin coloration, the haemoglobin having become disintegrated into globin heat coagulum and haematin. Wherever there is the slightest raw tinge in a joint, the temperature can never have reached 70° C. throughout. Special attention should be given to this fact in any recommendations as to cooking that may be made.

Metal melting at 80° C.

With the fusible metal melting at 80° C., the metal had run at ½ an inch from the surface of a large joint in 2 hours; at 1 inch from the surface of a small joint (No. 17) it had melted in 40 minutes; in a larger joint, at the same distance from the surface (No. 16), it had run in 1¼ hours; at 1¼ inches from the surface of a small joint the metal had melted in 60 minutes; at 1½ inches from the surface of a larger joint, it had not melted in 1½ hours. Here, again, we have much the same general results as in the last set of experiments. In large joints the temperature never ran up to 80° C. at more than 1 inch from the surface, whilst in small joints, especially those a little over-cooked, a temperature of 80° C. was reached at 1¼ inches from the surface in 60 minutes (No. 18).

Metal melting at 90° C.

As was to be expected, the metal fusing at 90° C. was never melted in a single experiment, so that it may be said that, except very near the surface, a temperature of 90° C. is seldom or never attained in any joint of 6 lbs., or even less, in weight.

All the joints referred to in the table were allowed to cool before they were cut open, as it was anticipated that the highest temperature was not reached near the centre of the joint when the meat was removed from the oven or pan, but that it probably continued to rise for some time during the process of cooling of the outer portion. This was actually found to be the case when the heating experiments were repeated—thermometers instead of fusible metal being used.

Roasting.

91 The corresponding series of roasting experiments gave practically similar, though from the consumer's point of view, even more unsatisfactory results.

Method roasting

The roasting experiments, in which fusible metal was used, were all carried out in a gas oven kept at a comparatively low temperature. From what has been already said in connexion with thermometer readings in meat, it might be anticipated that although the temperature in such an oven was lower and the time required for a given temperature to be attained in the centre of the joint much greater, the temperature throughout would be more equal, as was actually found, than when a higher temperature was used. Thus the difference between the outside and the centre would be less, but the actual temperature attained could never be so great. A low temperature oven then would give the least favourable condition as regards sterilisation of any tuberculous material that was contained in the joint being roasted, and the results obtained therefore are more to be relied on, being probably under rather than over-stated.

Relativ efficacy high an low tem peratur

92 The time required to roast a piece of a certain weight and dimension will naturally vary with the pattern of gas oven which is used, and the pressure of gas that is allowed to come into operation. When the meat is cooked slowly, the temperature attained by the central portion will naturally not be so high, but the maximum temperature attained will continue in action for a longer period of time.

But as the result of sterilisation experiments it has been shown that the effect of a higher temperature for a short time is much more efficacious in rendering infective material innocuous than that of a slightly lower temperature continued over a longer period of time. That this is specially true in the case of the tubercle bacillus will be seen on reference to the later sterilisation experiments. Part IX., p. 150 *et seq.*).

In carrying out the direct experiments with tubercular meat and with fusible metal a comparatively low pressure of gas was used in the oven, so that the process of cooking might go on as slowly as possible, and the range of temperature which came into operation would be, if anything, rather less than that which would usually be brought into play in actual practice, in the kitchen. This, as I have already said, was done because it was considered necessary rather to test the danger incurred where the conditions of sterilisation were least favourable, and to over-estimate rather than to underrate the possible risks of infection.

In this series of experiments the time allowed for roasting was 20 minutes for each pound.

Results.

Metal meltin 60° C.

93 In a sirloin weighing 6 lbs., the temperature, 1½ inches from the surface, was sufficiently high to cause the fusible metal (melting at 60° C.) to run in 2½ hours; at 2 inches from the surface, in two cases out of three, it was not melted in one hour, whilst in the third case the metal was melted at the end of two hours. In this case the joint was much larger, and, on reference to the table, will be seen to have been slightly underdone. At 2⅓ inches, the metal was melted in 2 hours and 20 minutes in a joint weighing 6 lbs., whilst in another weighing 9 lbs. it was not melted at the end of 3 hours. At 3 inches the metal was not melted in 2½ hours in one joint, and in 2⅔ hours in a second; whilst in two others, one slightly smaller, and one slightly larger, it was melted in 2⅓ hours and 3¼ hours respectively, it being noted in both cases that the meat was somewhat overcooked. At 4 inches from the surface the temperature never appears to have reached 60° C., the fusible metal remaining quite unaltered.

From this series of experiments it may again be gathered that the temperature in the centre of large joints never reaches 60° C., except where the meat may be said to be actually overcooked. The importance of this, when taken in connexion with the sterilising experiments, can scarcely be over-estimated, as it is evident that in rolled meat, when roasted, any smeared tubercular material which may have found its way into the centre of the roll would, in all probability, be almost unaffected by any temperature to which it would be submitted during the process of cooking. These tables are, under these circumstances, merely of value as being corroborative of the above facts, though they also show the distances to which the higher temperatures may penetrate—such distances from the surface of course being considerably less the higher the melting point of the metal that is used.

Metal melti 70° C.

For example, fusible metal with a melting point of 70° C. was never found to have run at a greater distance than 2½ inches from the surface; in only one case out of eight had it melted at 2 inches from the surface, and in two cases it had not melted at 1½ inches, so that it is only in very rare instances indeed that this temperature is attained at any very great distance from the surface. The haemoglobin red tells the same tale as in the boiling experiments.

Metal melti 80° C.

In the case of the fusible metal melting at 80° C., a positive result was obtained in only one case, and in that the metal had been inserted at a distance of only half an inch from the surface.

In a few cases, as will be seen on reference to the "remarks" column, tubercular material, which had been enclosed along with the fusible metal, was used with which to inoculate or feed animals, and the results obtained at once give an indication as to the series of temperatures that are necessary to be brought into play in order to render tuberculous material innocuous. It is, however, merely necessary to draw attention to

TABLE XIX.

Temperature Experiments with Fusible Metal (MELTING POINT 60° C.) placed in Meat. Roasting.

No.	Description and Weight.	Distance of Metal from Surface.	Time roasted.	Result.	Remarks.
26	Sirloin, 2,700 grammes (6 lbs.), 6 inches × 6 inches, rolled.	1½ inches	2½ hours -	Melted -	Overcooked. This roll was smeared with tubercular material, and both feeding and inoculation experiments gave negative results. *See* Part XI., Table No. XCVII., Material 2.
27	Shoulder, 3,000 grammes (6 lbs. 9 ozs.)	2 inches -	1 hour -	Not melted	Much underdone.
28	Roast, 1,500 grammes (3 lbs. 4½ ozs.).	2 inches -	1 hour -	Do.	
29	Shoulder, 4,500 grammes (9 lbs. 13½ ozs.).	2 inches -	2 hours -	Melted -	Slightly underdone.
30	Roast, 2,700 grammes (6 lbs.).	2½ inches -	2 hours 20 minutes.	Do.	
31	Sirloin, 4,050 grammes (9 lbs.), rolled.	2½ inches -	3 hours -	Not melted	Thermometer reading at 3½ inches from surface 51° C., and rising rapidly.
32	Sirloin, 3,600 grammes (8 lbs.), rolled.	3 inches -	2 hours 40 minutes.	Do.	
33	Sirloin, 2,700 grammes (6 lbs.), 6 inches × 6 inches, rolled.	3 inches -	2½ hours -	Melted -	Overcooked. This roll was smeared with tubercular material. Feeding and inoculation experiments gave negative results. *See* Part XI., Table No. XCVII., Material 2.
34	Sirloin, 3 600 grammes (8 lbs.), rolled.	3 inches -	2½ hours -	Not melted	Well done. Smeared with tubercular material. Tuberculosis was set up by both feeding and inoculation experiments. *See* Part XI., Table No. XCVII., Material 5.
35	Meat, 3,150 grammes (7 lbs.), rolled.	3 inches -	2½ hours -	Do. -	Thermometer reading at 1 inch from surface 63° C.
36	Meat, 4,700 grammes (10 lbs. 5 ozs.), rolled, 10 inches × 6 inches × 6 inches.	3 inches -	3¼ hours -	Melted -	Well done. This was smeared with tubercular material. Tuberculosis was set up by both feeding and inoculation experiments. *See* Part XI., Table No. XCVII., Material 6.
37	Roast, 3,600 grammes (7 lbs. 14 ozs.).	4 inches -	2 hours -	Not melted	This was smeared with tubercular material. Both feeding and inoculation experiments gave negative results. *See* Part XI., Table No. XCVII., Material 3.

TABLE XX.

Temperature Experiments with Fusible Metal (MELTING POINT 70° C.) placed in Meat. Roasting.

No.	Description and Weight.	Distance of Metal from Surface.	Time roasted.	Result.	Remarks.
38	Roast, 6,000 grammes (13 lbs. 2 ozs.).	1½ inches -	3 hours -	Not melted	Underdone.
39	Sirloin, 4,050 grammes (9 lbs.), rolled.	1½ inches -	3 hours -	Do.	
40	Shoulder, 3,000 grammes (6 lbs. 9 ozs.).	2 inches -	1 hour -	Do.	
41	Roast, 1,500 grammes (3 lbs. 4½ ozs.).	2 inches -	1 hour -	Do.	
42	Shoulder, 4,500 grammes (9 lbs. 13½ ozs.).	2 inches -	2 hours -	Do.	
43	Meat, 3,150 grammes (7 lbs.), rolled.	2 inches -	2½ hours -	Do. -	Thermometer reading at 1 inch from surface 63° C.
44	Sirloin, 3,600 grammes (8 lbs.), rolled.	2 inches -	2½ hours -	Do. -	Well done. Smeared with tubercular material. Tuberculosis was set up by both feeding and inoculation experiments. *See* Part XI., Table No. XCVII., Material 5.
45	Sirloin, 2,700 grammes (6 lbs.), 6 inches × 6 inches, rolled.	2 inches -	2½ hours -	Melted -	Not yet run; meat slightly overdone. This roll was smeared with tubercular material, and both feeding and inoculation experiments gave negative results. *See* Part XI., Table No. XCVII., Material 2.
46	Sirloin, 3,600 grammes (8 lbs.).	2 inches -	2 hours 40 minutes.	Not melted.	
47	Meat, 4,700 grammes (10 lbs. 5 ozs.), rolled, 10 inches × 6 inches × 6 inches.	2 inches -	3¼ hours -	Do. -	Well done. This roll was smeared with tubercular material. Tuberculosis was set up by both feeding and inoculation experiments. *See* Part XI., Table No. XCVII., Material 6.
48	Rump, 3,580 grammes (7 lbs. 13½ ozs.), 9 inches × 6 inches × 5 inches.	2½ inches -	3 hours -	Melted.	
49	Meat, 2,700 grammes (6 lbs.).	2½ inches -	2 hours 20 minutes.	Do. -	Not yet run.
50	Rump, 3,910 grammes (8 lbs. 1 oz.), 6 inches × 6 inches × 10 inches.	3 inches -	2 hours -	Not melted.	
51	Roast, 6,000 grammes (13 lbs. 2 oz.).	3 inches -	3 hours -	Do. -	Underdone.
52	Roast, 3,600 grammes (7 lbs. 14 ozs.).	4 inches -	2 hours -	Do. -	This was smeared with tubercular material. Both feeding and inoculation experiments gave negative results. *See* Part XI., Table No. XCVII., Material 3.

TABLE XXI.

Temperature Experiments with Fusible Metal (MELTING POINT 80° C.) placed in Meat.

Roasting.

No.	Description and Weight.	Distance of Metal from Surface.	Time roasted.	Result.	Remarks.
53	Sirloin, 4,050 grammes (9 lbs.), rolled.	½ inch -	3 hours -	Melted and run out.	
54	Meat, 4,700 grammes (10 lbs. 5 ozs.), rolled, 10 inches × 6 inches × 6 inches.	½ inch -	3¼ hours -	Not melted	Well done. This roll was smeared with tubercular material. Tuberculosis was set up by both feeding and inoculation experiments, with meat taken from the central portion of the roast. *See* Part XI., Table No. XCVII., Material 6.
55	Do. do. -	¾ inch -	3¼ hours -	Do. -	Well done. This roll was smeared with tubercular material. Tuberculosis was set up by both feeding and inoculation, with meat taken from the central portion of the roast. *See* Part XI., Table No. XCVII., Material 6.
56	Thigh, 4,050 grammes (9 lbs.).	1½ inches -	1½ hours -	Do.	
57	Meat, 3,150 grammes (7 lbs.), rolled.	1½ inches -	2½ hours -	Do. -	Thermometer reading at 1 inch from surface 63° C.
58	Thigh, 5,290 grammes (11¾ lbs.).	2½ inches -	1½ hours -	Do.	

the few results that were obtained in this set of experiments in order that they may be compared with the more systematic and regular series, carried out with tuberculous material mixed with milk, described in Part No. IX., p. 150 *et seq.*

It may be well here to make a somewhat detailed study of Tables XV. and XXI., comparing the temperatures recorded therein with those set forth in Tables LXXII. and LXXIII. It at once becomes evident that in only a very small number of cases could the heat to which the fusible metal was exposed, have been sufficient to render tuberculous material innocuous. It may be held that in Experiments 2 to 5, recorded in Table XV., a lethal temperature may possibly have been maintained for a sufficient length of time to kill the organisms, though this is extremely doubtful. In Experiments 1 and 6, however, there could be no such doubt, and the tuberculous material must have remained sufficiently virulent to set up infection, probably by feeding, and certainly by injection. There may also be some doubt in cases 10 to 12, Table XVI., and even also in 8 to 9, though, in these cases, the temperature was only just brought up to 70° C. apparently for a very short time. In cases 7, 13, and 14, however, there can be no doubt that tubercular material would not have been sterilised, and in case 13 this was proved by inoculation, which was followed by the development of tubercular lesions. In only one experiment in Table XVII., No. 21, would the temperature have been sufficiently high to kill the tubercle bacillus. In Nos. 2, 16, and 18 there may be a doubt in the matter, but in Nos. 5, 15, 17, 19, 20, and 22 the tubercle bacilli would probably have remained virulent. In two of them, Nos. 15 and 19, this was proved by inoculation, as in both of these cases the smeared and cooked meat still remained capable of setting up the tubercular process, as was proved by actual experiment. In experiments Nos. 23 to 25 (Table XVIII.) there can be no doubt that tubercular material would not have been sterilised. With material from the Experiment No. 23, tuberculosis was set up both by feeding and inoculation, but in that from No. 25 by inoculation only. In two cases (Nos. 26 and 33, Table XIX.) in which the joint was evidently over-cooked, and the fusible metal was melted, inoculations into guinea-pigs gave negative results. Experiment 37 is not a conclusive one, for although the fusible metal, melting at 60° C., had not run, both feeding and inoculation experiments with tuberculous material that had been introduced before the joint was cooked, gave negative results. In the remainder of the experiments in this group, nine in number, the tuberculous material placed in the meat would still have remained infective according to the temperatures recorded, and in two cases, Nos. 34 and 36, we have proof that this was the case, feeding and inoculation experiments giving positive results, *i.e.*, tuberculosis was set up. In the experiments recorded in Table XX., the tubercular material would have been destroyed in two cases, Nos. 45 and 48, or perhaps three, 49, according to the temperatures attained, but in No. 52, although the metal had not run, and therefore the temperature cannot have reached 70° C., the feeding and inoculation experiments gave negative results; it must therefore be held that, in this case, the heat was sufficient to destroy any tubercular material that was introduced.

In all the other cases, 11 in number, the tubercular material would have remained unaffected, or only partially devitalised, and in two cases, Nos. 44 and 47, positive results were obtained, both by feeding and inoculation; in these two cases, then, the results actually obtained according with those that would have been expected from the height and duration of the temperature maintained during the experiment. Of the experiments recorded in Table XXI., the tubercle bacillus would have been destroyed with certainty in one case only, No. 53. In Nos. 54 and 55, it is impossible to say what the results might have been, but in the other three, Nos. 56 to 58, there can be little doubt that the temperature attained at the points at which the fusible metal was introduced was not sufficient to render the tubercle bacillus innocuous.

CONCLUSIONS.

94 It is evident, then, that in the boiling and roasting experiments as ordinarily carried out in the kitchen, the temperature, however high it may be near the surface, seldom reaches 60° C. in the centre of a joint, except in the case of joints under 6 lbs. in weight. Ordinary cooking is quite sufficient to destroy any smeared material that remains on the outer surface of meat, *but it cannot be relied upon in the slightest degree to render innocuous the same smeared material when in the centre of a roll.* As these rolls are always subject to a good deal of handling and cutting during the process of making up, they are correspondingly more liable to contain such smeared material than ordinary joints, and the risk of their carrying infection is to that extent increased.

PART VII.

Temperature Experiments with Thermometers placed in the Meat which was afterwards subjected to a Process either of Boiling or of Roasting.

Object of the Investigation.

95 The object of this investigation was to determine the temperature attained at different distances from the surface of the joint, during the process of boiling or roasting, in order to control the experiments made with cooked joints that had been previously smeared with tuberculous material, and the fusible metal experiments. For this purpose the joints used were of different sizes, except in the case of the boiling experiments.

Boiling.

96 In the boiling experiments, joints were taken of as nearly the same size as possible, all between 6 lbs. and 7 lbs. 13 ozs. in weight, so that the condition in this set of experiments might be as constant as one could expect to obtain them. These joints and rolls were first firmly bound with strong twine. A puncture large enough to admit the bulb of the thermometer was then made in the fleshy mass. After the thermometer had been inserted the meat was firmly caught in a ligature carried around it, and enclosing the stem of the thermometer. The joint was then completely submerged in water brought up to, and kept in, an active state of ebullition by means of one or two of Fletcher's large Bunsen burners. In most of these cases, as in the other boiling experiments, a quarter of an hour's boiling was given for each lb. weight, but in one or two instances referred to in the table, a quarter of an hour less or a quarter of an hour more than the time usually recommended, was given. After the removal of the meat from the water, thermometer readings were taken every five minutes in order to determine how long any given temperature was maintained at the distance from the surface at which the thermometer bulb was embedded, this distance being measured to that point of the bulb which was nearest the surface of the joint.

In Table XXII. the results obtained in this series of experiments are set forth in full.

In the first column is given the number of the experiment for purposes of reference in the text; the second column contains a brief description and weight of the meat; in the third is given the distance of the thermometer bulb from the surface; after this comes the record of the temperature in degrees centigrade taken every 15 minutes, and then to the right of the heavy line is given the temperature as noted every five minutes during the cooling down process, after the joint has been removed from the water. In order to make this and the following tables as intelligible as possible, it will be useful to compare these figures with those obtained in connexion with the heating experiments carried on with natural and artificial tubercular milks which are recorded in Parts, Nos. VIII. and IX., *see* especially Tables Nos. LXXII. to LXXIV., pp. 177, 178.

It will then be seen that in only a few instances would the temperature have been sufficient, at the stated distances from the surfaces, to kill tuberculous material in joints of moderate size.

Thus, taking the temperature in the position occupied by the bulb of the thermometer the heat would be sufficiently great, and would be continued for a sufficient length of time, to destroy the tubercle bacillus with certainty in only two cases, Nos. 1 and 2, Table XXII. in the boiling experiments. In three cases 3, 4, and 8, the result would be doubtful unless the joints were allowed to cool down without being cut into, in which case the action of the heat would be sufficiently great and prolonged to put the matter beyond doubt, whilst in the remaining six cases the temperature attained could not be depended upon to effect thorough sterilisation of the tuberculous material situated at the point at which the temperature was recorded. These records should be compared with the results obtained in the fusible metal experiments, where also the joints were smeared with tubercular material.

Coming now to the roasting experiments, of which records are given in Tables XXIV., XXV. and XXVI., it is seen that of the joints roasted in the gas ovens the tuberculous material would have been sterilised without doubt in only three cases out of twelve. In two cases Nos. 21 and 22, the temperature was not high enough to sterilise at the time that the cooking process was discontinued, but it probably would have been if the joint had been allowed to cool before it was cut into. In the case of roast meat it may be accepted that the joint would be cut into whilst hot, so that the cooling down process may be left out of account in considering these figures. In the remaining seven experiments the tuberculous material (arguing from the milk experiments) would remain capable of infecting, in all cases by inoculation, and in some of them even by feeding. In Table XXV., where the thermometer readings were taken during the roasting of the meat in a coal fire oven, a larger proportion of complete sterilisation effects would have been obtained as the temperature was high enough in Experiments Nos. 26, to 29 and 32, to bring about complete devitalisation of the tubercle bacillus. In Experiment No. 30, in the same Table, the result is doubtful, but in three cases Nos. 31, 33, and 34, the tubercular material would still remain capable of setting up the tubercular process. In Table XXVI. the result is in every case unsatisfactory, as the temperature was never maintained sufficiently high or for a sufficiently long period, to render innocuous the tubercle bacillus situated at the points at which the temperature was taken. In all cases these results may be confirmed by comparing the figures in the tables mentioned (XXII. to XXVI.) with those recorded in Tables LXXII. to LXXIV.

Sources of error.

There is a point in connexion with these tables to which reference must be made before the figures are considered; it is this:—though glass is a bad conductor of heat, the mercury in the stem of the thermometer is an exceedingly good conductor, and, as soon as it comes to the level of the surface of the meat it is only separated from the heating medium in which the meat is being cooked by a comparatively thin layer of glass, which, bad conductor though it is, is soon traversed by the heat, the thin thread of mercury then serving as an admirable conductor between the surface and the mercury in the bulb. Bearing this in mind it will at once be argued that the temperatures in the meat would never have been quite so high had there been no connecting thread of mercury, and that the readings obtained must therefore be taken as indicating somewhat higher temperatures than were actually attained within the meat itself. As the surface is left, this factor of course becomes less and less important, so that the deeper readings may be safely taken as indicating fairly accurately the temperatures attained; the superficial readings, however, gave a temperature so much higher than is necessary to render tuberculous material innocuous, that for all practical purposes they are in these cases sufficiently accurate.

Details of experiments.

In experiment No. 1, with the thermometer bulb placed at three-eighths of an inch from the surface there is a rapid rise to 88° C.; as soon as the joint is taken from the water the fall is equally rapid, commencing at once and falling in 40 minutes as much as it had risen in 90 minutes.

In experiment No. 2, at double this distance from the surface, three-quarters of an inch, the rise goes on rather more slowly; it does not reach the same height, but only 80° C., and that in 120 minutes; it remains constant for about five minutes, and then tails off more gradually than in No. 1, falling in 105 minutes to the same temperature it took about 35 minutes to reach.

In experiment No. 3, at 1 inch from the surface, the rise was still more gradual to 73°·75 C., but the fall was slightly more rapid, taking only 65 minutes to pass through a scale that it had taken about 75 minutes to rise. In this case, however, we have a slight but certain irregularity both in the rate of the rise of temperature and in the fall.

The absence of the figures from the first few columns in the records of this and certain other experiments denotes that the mercury indicator had not risen high enough to be clear of the meat, and so could not be read.

In experiment No. 4, where the bulb was 1¼ inches from the surface, a slight irregularity is apparent, and it was thought at first that the measurement from the surface could not be accurate, as the temperature rose higher than in the case of No. 3, but on watching the cooling register it was noticed that the mercury continued to rise for 20 minutes after the joint was removed from the water; this was the first instance in which this had occurred, and it was therefore assumed that the distance from the surface was greater than in any of the previous experiments, the higher readings being due to some unpreventible or unforeseen factor in the experiment, such as leakage of water alongside the

TABLE XXII.

Thermometer Readings taken in Meat submerged in Water kept actively BOILING over Bunsen Burners.

Number of Experiment.	Description and Weight of Meat used.	Distance of Thermometer Bulb from Surface of Meat.	Temperature in Degrees Centigrade taken every 15 Minutes during Boiling.								Temperature in Degrees Centigrade taken every 5 Minutes after Meat was removed from the Boiling Water.																					Remarks.
			¼ hour.	½ hour.	¾ hour.	1 hour.	1¼ hours.	1½ hours.	1¾ hours.	2 hours.	5 minutes.	10 minutes.	15 minutes.	20 minutes.	25 minutes.	30 minutes.	35 minutes.	40 minutes.	45 minutes.	50 minutes.	55 minutes.	60 minutes.	65 minutes.	70 minutes.	75 minutes.	80 minutes.	85 minutes.	90 minutes.	95 minutes.	100 minutes.	105 minutes.	
1	Sirloin, 3,520 grammes (7 lbs. 13 ozs.), rolled.	⅜ inch	52	67	76	82	86	88	...	...	81	73	67	64	60	58	55	52½	...	...	...	...	...	...	...	...	...	...	...	...	...	Cooked at stable.
2	Salt beef, 3,520 grammes (7 lbs. 13 ozs.), rolled.	¾ inch	21	36	52	64	68½	73	78	80	80	77	74	72	70	68	65½	64	61½	59½	58½	58	56	54	53	51½	49½	48	47	45	44	Cooked at house.*
3	Salt beef, 3,520 grammes (7 lbs. 13 ozs.), rolled.	1 inch	...	...	...	53	59	64	70½	73¾	73¾	72	70½	69	67½	65½	63	61	59½	57½	56	54	53	51½	49	...	...	...	...	...	...	Cooked at house.*
4	Salt beef, 3,520 grammes (7 lbs. 13 ozs.), rolled.	1¼ inches	16½	26	46	52	62¾	65	71	75	77	78	78¾	78½	78¼	78	77¼	76½	75¾	75	74	73¼	72½	71½	70¼	69	68	67	66¼	65½	64½	Cooked at house.*
5	Beef, 2,700 grammes (6 lbs.), rolled.	1¼ inches	22½	30	41	51	58	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	Smeared and cooked at stables.
6	Sirloin, 3,520 grammes (7 lbs. 13 ozs.), rolled.	1¼ inches	23	29	35	42½	48	56	...	...	58½	60½	62	62½	63	63	63	62¾	...	...	...	...	...	...	...	...	...	...	...	...	...	Cooked at stable.
7	Sirloin, 3,520 grammes (7 lbs. 13 ozs.), rolled.	1½ inches	...	26	35	47	55	65	...	...	67	68	67	66	64	62	60	58	...	...	...	...	...	...	...	...	...	...	...	...	...	Cooked at stable.
8	Salt beef, 3,520 grammes (7 lbs. 13 ozs.), rolled.	1½ inches	15¾	20½	27	42	48¼	55½	63	66½	69	70½	71	71	71	70¾	70½	70¼	69	68¼	67	66½	65½	64½	63	61½	60	58½	57	56	55	Cooked at house.*
9	Sirloin, 3,520 grammes (7 lbs. 13 ozs.), rolled.	2 inches	...	...	...	37	44	55	...	...	58½	60½	62	62	63	63½	63¾	64	...	...	...	...	...	...	...	...	...	...	...	...	...	Cooked at stable.
10	Beef, 2,700 grammes (6 lbs.), rolled.	2 inches	...	...	...	...	...	53	57	...	58½	59	59½	60	60¼	60½	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	Smeared and cooked at stable.
11	Beef, 2,700 grammes (6 lbs.), rolled.	2¼ inches	...	...	...	38	46	55	65	...	68	69	70	71	72½	74	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	Smeared and cooked at stable.

* All those cooked at house were, after completion of experiment, served up at the table.

stem, or to a thicker indicator column of mercury in a shorter thermometer.

Experiment No. 5, in which the bulb was also 1¼ inches from the surface, serves to control the early readings of the two previous experiments.

Experiment No. 6 serves the same purpose; although the joint was cooked a somewhat shorter time than usual the temperature had only reached 56° C. when it was removed from the water; there was, however, after this a continuous rise for 25 minutes from 56 to 63° C., after which the mercury remained stationary for 10 minutes, and then fell a degree in the next five minutes, so that here was a repetition of what had already been observed in experiment No. 4.

In experiment No. 7, in which the bulb was placed 1½ inches from the surface, there must have been a "fault" in the joint of such a nature as to determine that the actual distance from the cooking medium was not so great as that indicated by the measurements from the apparent surface. There is evidence of this in the fact that the temperature rises rapidly to 65° C. and then only continues to increase for 10 minutes; the fall then goes on gradually for about 12 minutes, when it reaches the point at which it stood when the joint was taken from the water. The joint, however, was slightly smaller, and this may have something to do with the irregularity above mentioned.

In experiment No. 8, where the bulb was 1½ inches from the surface, the rise of temperature was very steady and gradual up to the end of 2 hours; after the joint was removed from the water the rise continued for 15 minutes and then went down steadily to 66°·5 C. during the next 45 minutes; and in the following 45 minutes fell to 55° C. or 11°·5 C.

In experiment No. 9, with the thermometer bulb at 2 inches from the surface, the temperature during the latter part of the boiling rose rather rapidly to 55° C.; when taken from the water it continued to rise for 40 minutes, when it had reached 64° C., and was still rising when the observations ceased.

In experiments Nos. 10 and 11 the same conditions are observed as in the above cases, which, however, were not continued for a longer time than was necessary to bring out the fact that in the later periods of the cooking process the rise in the temperature, even in the centre of a joint, had taken place much more rapidly than in the earlier periods. An extra quarter of an hours boiling makes a considerably greater difference in the temperature attained in the centre of a joint than would at first sight appear possible. Beyond this greater rise, however, comes in the factor that a much longer time is taken for the temperature to fall to the point attained when the joint was removed from the water. This is a most important fact, as the temperature once raised to a fairly high point in the depths of meat afterwards rises as much as 9° C. in half an hour (*see* Experiment No. 11), continues higher for some time, as long as 60 minutes or more (*see* Experiment No. 8), and when it commences to fall, does so very slowly, so that any material of an infective nature within the joint would be exposed to a comparatively high temperature for a very much longer time, and, as will be seen on reference to Tables LXXII. to LXXIV., p. 178, Part IX., exposure to a temperature a few extra degrees makes a great difference in the sterilising power of cooking, and the chance of any tubercular material being rendered innocuous is greatly increased. This applies only in the case of such joints as are allowed to cool before they are used, such as rounds of salt beef, and cold boiled meat, but it is a point which cannot be too strongly insisted upon in considering the means of rendering suspicious meat innocuous.

Importance of high temperature.

Roasting.

97 As has already been mentioned, the difference in temperature in ovens may be very considerable, whilst the temperature where meat is roasted before the fire may, again, differ from that attained in the various forms of oven; it was therefore thought necessary to roast joints in different ways:—

(1.) In gas ovens.
(2.) In coal heated ovens.
(3.) In front of a coal fire.

It is an easy enough matter to register the temperature attained in the oven. Where, however, the meat is roasted in front of the fire it is obviously a much more difficult matter to determine the exact temperature to which the meat is exposed. The amount of basting, the distance from the fire, the kind of reflector used, are all factors which can scarcely be taken into account without having access to the various kinds of screens and reflectors used, so that only a couple of records of the temperature to which meat would be exposed when roasted in front of the fire were made and kept; one without any screen at all, the other within a good reflecting screen.

Temperature in ovens prett regular.

In the ovens it was found that in the conditions under which the experiments were carried on the temperature was fairly constant, and did not vary very greatly in coal and gas ovens. This will be readily seen on comparing Experiments Nos. 24 and 25 (with maximum thermometers) carried on in the gas oven, with Nos. 35 and 36, carried on in the coal oven.

It should be remembered that in these experiments the door of the oven was opened every quarter of an hour, and that it had often to be kept open for some two or three minutes in order that the temperature readings might be accurately taken, the great heat coming from the oven setting up such strong air-currents that it was often difficult to keep the light steady enough to allow of the position of the mercury column register being noted; every time that the door was thus opened and kept open the temperature must necessarily have fallen considerably. In order to test the significance of this objection, the maximum thermometer was placed by itself in the various ovens near the front, so that the indicator could be readily seen; as soon as the door was opened the register was read as rapidly as possible and the door at once closed. The maximum thermometer readings are given in Table XXIII.

Use of max mum thermometer.

TABLE XXIII.

Maximum Thermometer Readings taken in Gas Ovens; in Ovens heated with Coal Fires; and in Front of Fire; to determine approximately the Temperature attained during Roasting.

Number of Experiment.	Description of Oven or Place where Readings were taken.	Temperature in Degrees Centigrade taken every 15 Minutes.										Remarks.
		¼ hour.	½ hour.	¾ hour.	1 hour.	1¼ hours.	1½ hours.	1¾ hours.	2 hours.	2¼ hours.	2½ hours.	
1	Gas oven in stable - - -	120	138	170	190	195	200	...	...	...	...	Gas full on.
2	Gas oven in stable - - -	180	190	195	198	199	200	200	210	...	...	Gas full on.
3	Gas oven in stable - -	160	170	177	180	181	183	183	185	186	188	Gas not turned on at full.
4	Gas oven in house - -	215	225	234	240	246	251	257	260	...	...	Good pressure of gas.
5	Gas oven in house - -	147	205	230	258	268	...	...	...	...	...	Good pressure of gas.
6	Oven with coal fire in house -	145	155	155	170	185	195	198	...	...	...	Fairly good fire.
7	Oven with coal fire in house -	170	177	177	215	...	...	...	...	...	...	Very good fire.
8	Oven with coal fire in house -	80	106	126	147	160	185	224	237	...	...	Condition of fire not noted.
9	In front of fire in house - -	122	122	...	...	...	...	...	...	...	..	Without screen. Index never rose higher.
10	In front of fire in house - -	155	162	...	...	...	...	...	...	...	..	With screen. Index never rose higher.

during the time that it was being cooked. Here, again, the direct action of the hot fat upon the thermometer cannot be excluded, but it is evident that basting undoubtedly greatly helps the cooking process.

In this set of experiments, owing to the comparatively low temperature attained at such short distances from the surface, there can be no doubt that had virulent tubercular material been introduced into the centre of the meat, it would not have been rendered innocuous by the heat to which it could have been exposed. In proof that they were supposed to be sufficiently cooked, it may be stated that the joints were all used at the table in the two houses in which they were cooked.

Conclusion.

102 Ordinary cooking, such as boiling, and more especially roasting, though quite sufficient to sterilise the surface, and even the substance, for a short distance from the surface of a joint, cannot be relied upon to sterilise tubercular material included in the centre of rolls of meat, especially when these are of more than 3 lbs. or 4 lbs. weight. The least reliable method of cooking for this purpose is roasting before the fire; next comes roasting in an oven, and then boiling.

TABLE XXV.

Thermometer Readings taken during ROASTING of Meat in Ovens with Coal Fire.

Number of Experiment.	Description and Weight of Meat used.	Distance of Thermometer Bulb from Surface of Meat.	Temperature in Degrees Centigrade taken every 15 Minutes during Roasting.														Temperature in Degrees Centigrade taken every 5 Minutes after the Meat was removed from the Oven.			Remarks.
			¼ hour.	½ hour.	¾ hour.	1 hour.	1¼ hours.	1½ hours.	1¾ hours.	2 hours.	2¼ hours.	2½ hours.	2¾ hours.	3 hours.	3¼ hours.	3½ hours.	5 minutes.	10 minutes.	15 minutes.	
*26	Beef, 3,825 grammes (8½ lbs.).	¾ inch -	.	.	.	.	68	76	80	80½	.	.	.	.	.	.	72	67	64	
†27	Beef, 4,365 grammes (9 lbs. 11 ozs.).	¾ inch -	.	32	41	54	60	67	70	79	83	86	98	99	100	100	.	.	.	
28	Beef, 4,365 grammes (9 lbs. 11 ozs.).	1 inch -	20	27	35	48	54	62	66	75	79	83	96	98	99	100	.	.	.	
*29	Beef, 3,825 grammes (8½ lbs.).	1 inch -	44	46	55	62	68	75	78	79	.	.	.	.	.	.	76	72	68	
*30	Beef, 3,825 grammes (8½ lbs.).	1¼ inches -	.	.	.	.	.	.	.	72	.	.	.	.	.	.	72	71	70	
31	Sirloin, 3,770 grammes (8 lbs. 6 ozs.).	1¼ inches -	17	23	25	30	38	43	50	55	65	.	.	.	.	.	.	.	.	
†32	Beef, 4,365 grammes (9 lbs. 11 ozs.).	1¼ inches -	22	29	41	54	60	67	70	80	84	87	98½	99½	100	100	.	.	.	
33	Beef, 4,050 grammes (9 lbs.).	4 inches -	24	27	38	43	.	.	.	.	.	.	.	.	.	.	.	.	.	Thermometer broke after the temperature at 1 hour had been taken.
34	Sirloin, 4,725 grammes (10½ lbs.).	4 inches -	23	24	25	31	42	51	.	.	.	.	.	.	.	.	.	.	.	This was said to be quite ready for the table after 1½ hours cooking.
*36	Maximum thermometer -	Placed on same shelf in oven as meat.	145	155	155	170	185	195	198	195	.	.	.	.	.	.	.	.	.	The maximum thermometers were placed in the ovens to register the highest temperature attained whilst the meat was being roasted.
†36	Maximum thermometer -	Placed on same shelf in oven as meat.	170	177	177	215	.	.	.	.	.	.	.	.	.	.	.	.	.	

After completion of experiment, all these joints were served up at the table.

TABLE XXVI.

Thermometer Readings taken during ROASTING of Meat in front of a Coal Fire.

Number of Experiment.	Description and Weight of Meat used.	Distance of Thermometer Bulb from Surface of Meat.	Temperature in Degrees Centigrade, taken every 15 Minutes during Roasting.										Temperature in Degrees Centigrade, taken every 5 Minutes after Meat was removed from the Fire.															Remarks.
			¼ hour.	½ hour.	¾ hour.	1 hour.	1¼ hour.	1½ hour.	1¾ hour.	2 hours.	2¼ hours.	2½ hours.	5 minutes.	10 minutes.	15 minutes.	20 minutes.	25 minutes.	30 minutes.	35 minutes.	40 minutes.	45 minutes.	50 minutes.	55 minutes.	60 minutes.	65 minutes.	70 minutes.	75 minutes.	
37	Sirloin, 2,025 grammes (4½ lbs.)	¾ inch	11	21	32	46½	53½	60	65½	...	...	...	65½	66	65	63½	61	59½	56½	54½	52	51	49	46½	44½	42	41	After completion of experiment all these joints were served at table.
38	Sirloin, 2,025 grammes (4½ lbs.)	1 to 1¼ ins.	...	...	...	...	...	46	52	...	...	...	52¼	52½	52¾	52¾	52½	52	51	50	48	47	45	...	...	...	...	
39	Sirloin, 2,025 grammes (4½ lbs.)	1½ inches	...	12½	15½	29½	38½	48	56	...	...	...	57½	59½	62½	63½	64	64	64	63	61	60	58½	56½	54½	51½	50	
40	Beef, 3,600 grammes (8 lbs.) -	1½ inches	24	27	31	38	43	49	56	60	...	...	...	...	...	...	...	...	...	...	...	...	..	...	...	...	...	
41	Sirloin, 4,500 grammes (10 lbs.)	1½ inches	20	25	30	35	40	50	55	64	70	75	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	

PART VIII.

Feeding and Inoculation Experiments (controlled by Experiments with Raw Milk) with Milk heated at various Temperatures, taken from Cows with Tubercular Udders.

Object of the Investigation.

103 This investigation was planned with the object of determining the conditions of temperature that are necessary to render innocuous to animals milk taken from cattle with distinctly tubercular udders (and in which tubercle bacilli could be demonstrated by means of the microscope), either by feeding or injection into one of the serous cavities or into the subcutaneous tissues. In this series of experiments it was thought that the inoculations would assume far greater importance than in the case of infection by meat, for the reason that it was found in the earlier experiments that animals, pigs especially, that succumbed to tuberculosis after being fed with tubercular milk were frequently attacked through the tonsils as well as from other parts of the alimentary tract. In some of the preliminary experiments, it was also found that milk heated to a considerably higher temperature than that to which it was found necessary to subject it in order to render it innocuous to guinea-pigs by feeding, was still capable of setting up tuberculosis not only when inoculated intraperitoneally in the same species but also when brought in contact with the alimentary tract, especially the tonsils, of a different species such as the pig. It was, in fact, concluded at a very early stage of the investigation that so long as this material remained capable of producing infection when introduced either into the subcutaneous tissues or into the peritoneal cavity, so long did it remain capable, when ingested, of setting up infection in the pig, the infection in such cases usually commencing in the tonsils. As this method of infection was found to be so uniform, and as it corresponds so accurately with what is found to occur in scrofulous children in whom the glands of the neck are so frequently affected by a tubercular lesion, the injection experiments assumed such importance that they were in all cases carried on at the same time as the feeding experiments, with the result, of course, that the number of experiments was very considerably multiplied beyond what in the first instance had been anticipated. It will be seen, however, that these injection experiments could not have been omitted if the report was to be complete, as in the majority of cases in which the heated milk was no longer capable of setting up tuberculosis in the guinea-pig, it still set up infection when injected into that species and when ingested in the case of the pig. It was with this end in view that I incurred the risk of prolonging the experiments beyond the time originally mentioned, and of deferring the preparation of the report until these experiments could be completed.

Importance of this series of experiments.

Tonsils affected in pigs.

Infectivity by injection equal to infectivity through tonsil.

Multiplication of experiments.

The earlier experiments were all carried on with milk that was obviously tubercular, that is, milk that had been drawn from cows in which the udder was irregularly enlarged, the glands adjoining the quarters affected being in a similar condition, the cow at the same time suffering from localised or general tuberculosis, whilst, finally, tubercle bacilli could in all cases be demonstrated in the milk in larger or smaller numbers according to the extent of the infection and the rapidity of the process of breaking down that was going on in the udder. In those cows that were kept under observation until they were slaughtered, the characteristic tubercular structure and tubercle bacilli were demonstrated in the udder by means of special histological investigation after the animal had been killed. Under these circumstances it would scarcely have been necessary to make many control experiments, but as it was only possible to determine the effects of heating on the infectivity of the milk by comparing the results obtained with those that were obtained when unheated (raw) milk, control experiments were made in nearly all cases; as however the results obtained by other experimenters have been so conclusive, it is not necessary here to do more than mention these control experiments, and to refer the reader to Part No. XII., p. 221 *et seq.*, in which the details of the experiments made with tubercular milk are given.

Earlier experiments with tubercular milk.

Tubercle bacilli in the milk,

and in the udder.

Control experiments.

Experiments with Tubercular Milk.

104 This series of experiments was made entirely with the milk from four cows (Nos. 20, 21, 24, and 25) in which the degree of tuberculosis of the udder was so marked that there could be no doubt that if tubercular

Cows from which milk was taken.

milk could produce tuberculosis this was suitable material with which to try the experiments.

Tubercular milk from cows with non-tubercular udders.

A few other experiments were carried out with the milk from two tuberculous cows, Nos. 26 and 27, in which, however, the udders were not affected; the control experiments (*i.e.*, those in which raw milk from these cows was used) in these cases gave absolutely negative results, so that the milk from these two cows could be of no value as material to be used in a series of "sterilising" experiments. Another cow which was sent to us after being subjected to a veterinary examination and was reported to be a "waster" or "piner," and probably suffering from tuberculosis, was in a state of extreme emaciation. The milk from this cow was also used for preliminary experimental purposes, although, as in the two cases above-mentioned, no tubercle bacilli could ever be demonstrated in the milk. The results obtained in the experiments in which this milk was used were invariably negative, and it was afterwards used only when mixed with tuberculous organs for some of the heating experiments. It will thus be seen that the raw milk taken from three cows which were or were supposed to be tubercular, give no positive results when injected intraperitoneally. The first two on being slaughtered were found to have perfectly healthy udders, though they both suffered from more or less marked tuberculosis in other parts of the body, whilst in the third (the "waster") when slaughtered not a trace of a tubercle could be found in any part or organ of the carcase. For obvious reasons this animal is not included amongst those described in Part No. X. of this Report.

Other milks used for experiment.

It may be mentioned that certain other small samples of milk from cows with tuberculous udders, sent as control material, set up tuberculosis in every instance where tubercle bacilli could be demonstrated; these samples were, however, so small that none of them could be used for sterilisation purposes. I was, unfortunately, in some cases, unable to secure the cows from which the samples were taken as they were either slaughtered or sold without the knowledge of the veterinary surgeon before he or the owners could be communicated with.

Quantity of milk drawn from tubercular udders.

It has frequently been observed that where the udder has been affected with tuberculosis there is, especially in the earlier stages of the lesion, no perceptible falling off in the yield of milk, in fact it has been maintained by some that there is an actual increase; this increase has, however never been observed in the case of any of the cows at the stage at which they came under our observation; there were, undoubtedly, cases in which the amount of milk given appeared to be quite equal to the average obtained from healthy cows, the only indisputable alteration being that the milk was usually more watery-looking than normal, and when poured in a thin layer over a glass plate was found to contain larger flocculi or fragments than are met with in milk taken from a healthy udder. After a time the yield of milk becomes somewhat diminished in the quarter specially affected, which is usually enlarged and hard, and on superficial observation, would appear to be the one from which the largest quantity of milk should be drawn. As the yield diminishes, the consistency of the fluid becomes much more irregular, ultimately becoming thicker and thicker; on spreading out on a glass plate this thickening is found to be due to the presence of large quantities of fragments rather than to an equal distribution of solid matter throughout the milk, so that on allowing the milk to stand a superficial layer of thin fluid is left, and a deposit of more solid matter made up of the flocculi and fragments above-mentioned. If during this stage or even in the earlier stages, the little fragments seen on a glass plate over which the milk is run, or collected from milk that has been allowed to stand, or that has been centrifugalised, be stained for tubercle bacilli by the Ziehl-Nielsen method and examined under the microscope with a moderately high power, numerous tubercle bacilli may be found in them. In these cases it was possible to demonstrate the presence of bacilli in milk that, immediately before the animals were examined, was actually being supplied for human consumption.

Flocculi in thin watery tubercular milk.

Milk thicker but often serous.

Sero lent

Then comes a period during which the milk is first purulent looking and then sero-purulent; for example, the milk at this stage, from cow No. 20, was described as being "a slightly purulent thick yellowish fluid, on "the following days it became much more serous in "character until it could no longer be recognised as "milk at all; it had a distinctly alkaline reaction."

Mil No.

In cow No. 21, great physical differences were observed in the milk from the various teats. The milk from each of the four teats of this cow was collected separately in different vessels. The milk derived from the two teats, right anterior and right posterior, appeared to be perfectly normal when spread out in a thin layer on glass. It was of fairly good colour and consistence, and none of the small particles already mentioned could be made out. The milk from the left anterior teat also appeared to be normal in appearance, until carefully examined, when it appeared to be thinner than usual, and when spread out in a thin layer on glass small fragments or flocculi could be distinctly seen. The left posterior teat yielded only a small quantity of a brownish serous fluid, which, when spread out in a thin layer on glass, showed the presence of a very large number of minute granules and flocculi. It is interesting to note that the amount of albumen present in the fluid drawn from the left side, and especially from the left posterior teat, was so large that when the mixed milk (milk from the four teats) was heated for only 15 minutes at 80° C., it became slightly thicker and gelatinous; at the end of 30 minutes it had became quite thick; at the end of 45 minutes it was still thicker, almost like paste, and in one hour it had become so solid that when the beaker containing it was inverted the milk remained in the vessel.

Tub bacil udde thou foun milk,

Tubercle bacilli were afterwards demonstrated, first, in the milk from the left posterior teat, and then in the left anterior teat; they may also have been present in one of the other teats at a later stage of the disease, but they were never demonstrated under the microscope, although in the udder, after death, bacilli were found in both the two left quarters and in the right posterior quarter.

Norn looki distii infec

It will be readily understood how such a diseased udder may be a source of infection to a large quantity of milk; even if the serous fluid from the left posterior teat were discarded by the milker during the later stages of the disease, that drawn from the left anterior teat would undoubtedly have been considered fit to pass into circulation unless the nature of the lesion had been recognised and the danger of infection pointed out. The milk from the other quarters of the udder was so abundant in quantity, and the physical characters differed so slightly from those of normal milk, that a dairyman would see no reason to keep such milk out of circulation.

TABLE XXVII.

Injection Experiments with Raw Milk taken from the Separate Teats of Cow No. 21.

Teat or Teats from which Milk was taken.	Number of Animals in each Experiment.	Intraperitoneal Injection.	Died or Killed and Number of Days.	Post Mortem Examination and Remarks.
Left anterior teat - -	1 Guinea-pig -	1 cc. - - -	Died 33 - -	**Tubercular.**
Do. - -	1 do. -	1 cc. - -	Died 53 -	**Tubercular.**
Left posterior teat - -	1 do. -	1 cc. - - -	Died 6 - -	Too early to show tubercle.
Do. - -	1 do. -	1 cc. - -	Died 30 -	Nil.
Right anterior teat - -	1 do. -	1 cc. - - -	Killed 93 - -	Nil.
Do. - -	1 do. -	1 cc. - -	Killed 127 -	Nil.
Right posterior teat - -	1 do. -	1 cc. - - -	Killed 127 - -	Nil.
Do. - -	1 do. -	1 cc. - -	Killed 127 -	Nil.
Mixed milk from all four teats - - -	1 do. -	1 cc. - - -	Died 32 - -	**Tubercular.**
	1 do. -	1 cc. - -	Died 30 -	**Tubercular.**
Do. - - -	1 do. -	1 cc. - - -	Died 28 - -	**Tubercular.**
Do. - -	1 do. -	¾ cc. - -	Died 29 -	**Tubercular.**

In this serous "milk" large fragments of caseous or caseo-purulent tissue, sometimes the size of a pea, may often be found floating, though in other cases no fragments of any kind can be found. Micrococci, probably ordinary pus organisms, are often met with, but it is sometimes very difficult to demonstrate the presence of the tubercle bacilli in this clear fluid, although they may almost invariably be demonstrated in the fragments of tissue, sometimes more, sometimes fewer than when the more general breaking down, of which we have evidence in the minute flocculi in the earlier stages, is taking place. That this serous fluid still retains a very high degree of infectivity was proved on several occasions by inoculation experiments, though in one case in which it was used, and where the pus organisms appear to have gained the upper hand, inoculation of two guinea-pigs, with the clear serous fluid gave negative results, one dying too early to show tuberculosis, the other developing no tubercular lesion in 30 days, whilst the milk from the left anterior teat, which was comparatively normal in appearance, proved fatal to both of the guinea-pigs that were injected with it. The milk from the opposite side, at this stage, also remained innocuous. When the milk from the four teats was mixed and injected into four guinea-pigs it proved fatal in every instance, each animal succumbing to a virulent attack of tuberculosis.

It will be seen from the above table that five out of the six guinea-pigs that died from tuberculosis died within five days of each other—between the 28th and the 33rd day—the sixth animal lived some time longer, 53 days.

Here, then, we have most remarkable evidence of the regularity with which the disease is produced, and the regular time in which death occurs when the disease is set up by the same material.

The milk taken from the right side of the udder from both anterior and posterior teats could be injected with perfect impunity, the animals continuing well in every respect until they were killed in order to determine the result of the experiment, when absolutely no trace of tubercle was found.

The serous fluid taken from the left posterior teat, which was the first affected, evidently contained a number of septic organisms, though there was no evidence of the presence of tubercle bacilli, for, as a result of these inoculation experiments, one animal died of septicæmia six days after the injection had been made, and, although a second lived for some time longer, it ultimately succumbed on the 30th day with evidence of the presence of septic inflammation, but none of tuberculosis. Special attention is drawn to this couple of experiments in order to show that tubercle bacilli, though present at one period in the milk, and probably present in some part of the quarter of the udder from which it was drawn, may, during certain times, especially when there is comparatively little breaking down of the glandular tissue and walls of the ducts going on, and where also there is evidence of septic inflammation, contain few or no bacilli. It must be borne in mind, however, that a sudden recurrence may take place at any time. This corresponds exactly with the conditions met with in *phthisis pulmonalis* in the human subject.

A most important point in this connexion is that the spread of tubercle in the udder goes on with most alarming rapidity; this I was able to observe in the cows constantly under observation, but I have also noticed on several occasions during the interval between fortnightly inspection carried on along with a veterinary surgeon, that the disease has become distinctly developed. It may be, of course, that the early evidence has been overlooked at the previous inspection, but whether this is the case or not, the spread of the disease was so rapid as to afford very good ground for alarm. The very absence of any definite signs in the earlier stage is one of the great dangers of this condition, and one that it is very difficult to guard against. So much impressed is one by this fact that whatever steps may be taken as regards the treatment of tuberculous cattle in relation to the meat supply, there can be no doubt that any animal suffering from tuberculosis of however mild a character should be at once stringently eliminated from dairy stock. That this will be the best policy not only on behalf of the consumer, but also in the interests of the dealer, will become evident, especially if it be understood that if the animal is at once condemned and killed certain portions of the carcase *may* be used for human food, but that if the animal is kept until tuberculosis is allowed to become diffused or generalised throughout the body the carcase can not only not be looked upon as of any value as part of a food supply, but must be considered as actually a very real source of danger to the community, and especially to that part of the community least able to protect itself.

Tubercular udder met with in all stages of disease in cattle.

A most important fact to be borne in mind in connexion with tubercular disease of the udder is that it is not by any means confined to those cattle in which tuberculosis has invaded many of the other organs, and is not necessarily associated with an advanced stage of the disease, so that the degree of tuberculosis as made out clinically, apart from changes in the udder, is in many instances no guide as to the changes in the udder itself. If we turn to the post-mortem examinations made by Dr. Martin and myself of Cows Nos. 8, 20, 21, 24, and 25, it will be seen that the tubercular disease of the udder accompanies all stages of tuberculosis in the animal, though it will be observed that even in Cow No. 8 (*see also* Dr. Martin's Report), in which most of the organs and serous membranes are perfectly normal, the mesenteric and omental glands are tubercular, whilst there is also marked evidence of the presence of old tubercular disease in the mucous membrane of the intestine.

In No. 20 (*see* Part X. of this report, p. 194) the disease is localised to the serous membranes near the base of the chest, to the peritoneum, and to the intestinal tract, in the latter of which there was a distinct tubercular deposit in the mucous membrane; here again the lymphatic glands were much more extensively affected than the organs above mentioned, the bronchial glands containing old caseo-calcareous deposits as well as recent tubercle, and the glands in the abdominal cavity showing evidence of a comparatively recent affection; the disease, however, as ordinarily classified, would be comparatively slight, whilst the udder and the milk ducts were undoubtedly in an advanced stage of tuberculosis.

In the next case, Cow No. 21 (*see* Part X., p. 195), the disease was specially in and around the uterus; there was some ulceration of the intestine and extensive affection of the lymphatic glands; the lungs were tubercular, as were also the bronchial and mediastinal glands; the udder was in an advanced stage of tuberculosis.

In Cow No. 24 (*see* Dr. Martin's report, Part V., p. 56), we have the same conditions, but in a somewhat more marked degree, as the kidneys and suprarenal bodies are also affected, and the glands even more so than in Cow No. 21.

In Cow No. 25 (*ses* Dr. Martin's report, Part V., p. 57) the disease is still more generalised.

On the other hand it is within the experience of every veterinary surgeon that a cow may be in an advanced stage of generalised tuberculosis, although there is not the slightest trace of tubercular disease in the udder, but in spite of this, as we have seen, it would be an extremely dangerous practice to allow milk from such an animal to pass into the market, as the disease may at any time extend to the udder, and this with most alarming rapidity. It is, therefore, necessary to accentuate the recommendation already given, that *no cow suffering in the slightest degree from any form of tubercular disease should be allowed to remain on a dairy farm.*

APPARATUS USED IN THESE EXPERIMENTS FOR KEEPING THE MILK AT A CONSTANT TEMPERATURE.

105 As it was necessary to maintain the milk at a regular and equable temperature for a considerable length of time, a special piece of apparatus had to be devised. Mr. Hearson made, to my design, a modification of his incubating apparatus to act as a sterilise, by means of which this result was readily attained. This steriliser consists, essentially, of a double water-bath, the outer of these water-baths, (*a*) having a capacity of four gallons encased on five sides in wood (*b*) (which as is well-known is a bad conductor of heat); this is heated through a small flue (*c*), by means of a gas flame (*d*). Suspended in this outer chamber of water is a large copper cylinder (*e*) also containing four gallons, which is about three-quarters filled with water, and is covered with a conical double copper-lid (*f*). Placed in the outer water chamber is the regulating apparatus, which consists of a lever fixed at one end (*g*), having attached to it by a pin at a short distance from the hinge a vertical rod (*h*) which passes downwards, something like the piston of a safety valve, into a small chamber or cup (*i*), in which the end rests on a small metal capsule containing a mixture of ethereal fluids; this mixture boils at a certain fixed temperature. Different mixtures of these ethereal fluids boil at different temperatures, so that with a series of these capsules any required temperature may be obtained. As soon as the required temperature is reached the capsule expands, the lever is raised, and a flue (*k*) is opened to allow of the escape of heat directly instead of after it has passed through the U-tube (*c*), which is placed at the lower part of the outer water-chamber; this is directly in contact with the water, and is continued into the flue (*m*). When the heat passes through this tube along which it is directed by a damper (*l*), which is thus allowed to fall when the capsule collapses, the water is again heated. When it passes directly outwards as a result of the damper being raised, very little heat can pass along the tube and little is taken up by the water, the temperature of which immediately begins to fall and continues so to do until the ether again becomes liquid, the capsule contracts, and the damper again falls. By altering the position of a sliding weight (*n*) on the lever at the end of which the damper is placed, a certain amount of pressure is kept on the capsule, and the action of the temperature on the capsule in elevating the lever is slightly modified. This weight thus serves as a means of regulating, within a degree, the temperature attained in the water, and also of counteracting, to a certain extent, rapid barometric changes. I was supplied with a series of capsules by the aid of which any required temperature between 50° C. and 100° C. could be obtained in this "steriliser."

This apparatus is illustrated in Plates XXI.–XXII. at the end of the Report.

Method of Procedure.

Early method of procedure.

106 In the first series of experiments the cold milk was poured into small glass beakers, which were at once placed in the inner compartment of the "steriliser," which had previously been raised to 70° C., the temperature at which the heating was to be carried out. As the milk was put in cold it was evident that the temperature attained was not, during the whole time that the milk was exposed to the heat, equal to that which was ultimately attained, *i.e.*, the temperature of the surrounding water. Indeed, it was afterwards thought that this might account for the tuberculosis that was developed in two guinea pigs, injected with tubercular milk that had been exposed to a temperature of 70°C. for 11 and 12 minutes respectively in long narrow glass tubes, and in one guinea pig that had been fed with similar tubercular milk heated to 70° for 15 minutes. (*See* Table XXXIV., p. 148.)

Plan of procedure adopted.

This method being evidently open to objection as not being sufficiently accurate for our purposes, though it is the method that is most frequently used for domestic purposes, the milk, in succeeding experiments, was in the first instance rapidly heated (in a flask over the naked Bunsen burner for the higher temperatures and in a water bath for the lower temperatures) to the required temperature, 60°, 70°, or 80° C., as the case might be, a thermometer being kept in the milk during the process, and the milk being constantly agitated. This heated milk was then placed in beakers of from 50 to 300 cc. capacity, that had previously been heated to the required temperature by being plunged into hot water. When the milk had been heated up to the same temperature as the water in the steriliser, there was, of course, no object in having thin columns, such as were used when it was thought necessary to use milk introduced cold into the steriliser. The beakers were weighted at the bottom with lead, and filled to such a height that when floating in the water the level of the milk within the beaker was rather lower (from one quarter to one half inch) than that of the surrounding water, and care was always taken in introducing the milk not to allow any of it to come in contact with the lip or side of the beaker that would remain above water during the heating process; whenever such accidental contamination occurred the beaker was immediately re-sterilised.

In this way, having the beakers warm and the milk heated to the point required, or even a degree above the temperature at which the experiment was being carried on, to allow of a slight loss of temperature in the transfer of the milk from the flask to the beaker, the milk was maintained during the whole time recorded in the tables at or within one or two degrees of the desired temperature. Accurate records of the thermometer readings in some of these experiments are given at the head of the tables (Part IX. pp. 151, 155, and 159) preceding the description of some of the actual experiments. These may be taken as being fairly representative samples of the temperature attained during the heating-up process, not only in these but in the other experiments carried on under the same conditions. It has been thought well, before drawing conclusions and making practical recommendations, to draw attention to the above possible error of experiment, though it must be concluded that the experimental error that can creep in in a long series of experiments, where those who are engaged on them must acquire considerable experience and manipulative skill, must be very much less and their results greatly more accurate than in the hands of those who must carry on the sterilising process purely as a matter of routine. Where, then, a single case of tuberculosis has occurred as the result of feeding or inoculation experiments, carried on with meat or milk that has been subjected to a certain temperature for a certain period in our hands, it is evident that such time and degree of heating are not sufficient when used as a practical means of disinfection by those who would be appointed to carry on the disinfection of a food supply in order to render it innocuous. A wide margin beyond the experimental area of safety should therefore be allowed for in drawing up recommendations for the sterilisation of possibly tubercular material. For this reason experiments were, as will be seen on reference to the tables, in most cases carried on far beyond the degree and time required for actual sterilisation of tuberculous material.

Neces margi beyon sugge by res obtain from ments

Instruments used in Experiments.

Syrin

107 Several forms of syringe and pipette were made use of in different sets of experiments, but ultimately a large syringe, made on Koch's pattern, the barrel of which was capable of holding from 5 to 15 cc. of the material to be injected, was selected as the best form to use, both because it could be conveniently sterilised, and because a syringe of this size would hold a sufficient quantity of milk with which to inject several animals of the same series without having to refill the syringe, a matter of no small importance when a considerable number of injections had to be made.

Needl

The needles used were specially made, and had a bore of considerable size. A large number of these needles were used, as they were so soft that they soon became blunted; they were, however, so inexpensive that it was deemed better to use fresh needles than to attempt to clean and sterilise them too frequently.

Meth sterili syrin

The syringe comes to pieces very readily; there is no piston to the crevices of which infective material might gain access, the nozzle and india-rubber bulb are simply ground on to the glass tube and come apart quite readily; there is no screw at any point of the metal or of the glass, and the whole may be readily taken to pieces and sterilised. This latter was done immediately after use by placing all the parts in 5 per cent. carbolic acid for five minutes; they were then rinsed with water, and afterwards with methylated spirit, and carefully dried, when they were again ready for use. The india-rubber ball was sterilised in a similar fashion.

Meth maki inject

In making a series of injections, in order to minimise as far as possible any risk of accidental infection, the injections were first made with the material that had been longest exposed to the temperature at which the experiments were being carried on. For example, when samples of milk were being heated for times varying from a few minutes up to two hours, the milk heated for two hours was first injected, and then that heated for one-and-a-half hours, and so on downwards, to the one that was merely heated for a few seconds at the special temperature, so that the risk of carrying infective material from one set of experiments to another was reduced to a minimum. After all the heated milk had been injected the control experiments were made.

Coolin the m befor

After the milk had been heated and before it was injected, it was cooled down to the temperature of the body by floating the beaker in cold water to prevent the further action of the heat, and also to allow of its being injected into the animal without causing discomfort or shock. When the milk had to be used on several successive days it was kept in an ice safe, but before it was injected it was again heated to the temperature of the body. So little did most of the animals feel these injections that they commenced eating any food that was in their cage immediately after being returned, and the majority of the animals remained so well up to the time they were killed in the lethal chamber (a large jar filled with chloroform vapour), that it was impossible, without very careful examination of the animals (and sometimes not even then), or examination of the labels, to tell whether and where the animal had been injected.

Preca taken durin ing ex ments

In the feeding experiments it was found that the milk went sour in the zinc troughs very rapidly, and the utmost care had to be exercised to keep these troughs sweet. For this purpose they were kept immersed in boiling water for two or three minutes before the milk for each fresh feeding was put into them. When this matter was attended to the guinea pigs took the milk greedily, but if the milk was in the slightest degree tainted they refused to touch it unless they were extremely hungry. In some of the earlier experiments the milk was mixed with bran or bread, as it was thought that the animals might take it better when so mixed, it was afterwards found, however, that this was quite unnecessary, and it was thought too that the milk when given alone might exert any infective influence it might have on the walls of the intestine more readily than when mixed with solid matter, so that in all but the earliest experiments the milk was given by itself.

108 Description of Experiments.

Coming now to the experiments carried on with milk from Cows Nos. 20, 21, 24, and 25, all suffering from tubercular affection of the udder, it is necessary to determine the conditions under which milk may be sterilised by heat. The first series of experiments to be described was the series carried on with milk from Cow No. 20.

This milk was described as a slightly purulent thick yellowish fluid on the first day on which it was used; on the following days it became much more serous in character until it could no longer be recognised as milk. It was of distinctly alkaline reaction, and when smeared on a cover glass and stained by the Ziehl-Nielsen method and examined microscopically it was found to contain a large number of tubercle bacilli. This milk was first heated up to 60° C., after which it was poured into beakers which had been heated up to the same temperature; samples were then maintained at that temperature for 15 and 30 minutes respectively in the closed steriliser, after which they were rapidly cooled down to the temperature of the body by placing the beakers in cold water, before the milk was used for feeding and inoculation experiments. It contained such a large number of tubercle bacilli and was so evidently tubercular that only three control feeding experiments and three injection controls were made, all on guinea-pigs. That it was extremely virulent may be gathered from the fact that in every case, both of feeding and inoculation, positive results were obtained.

109 Control Feeding Experiments.

Control feeding experiments.

It is of interest to note that in these control feeding experiments ulceration occurs with great regularity in both the large and small intestines where the raw tubercular milk has been ingested by guinea-pigs (*see* control feeding experiments Part XII., Table No. XCIX., p. 222). From the constant occurrence of this condition it might be argued from what has already been said in connexion with the production of tuberculosis by feeding with the raw tubercular glands, that here also are present in the milk not only tubercle bacilli in considerable numbers, but also a large quantity of the poisonous material formed by these organisms or stored up in them. It must, however, be remembered that in the case now under consideration the animals lived for some time after they had been fed, so that although this poisonous material may have had something to do with the bringing about of the ulceration its importance can scarcely be so great as in the cases where raw tubercular glands were used. Another fact which is again brought out most distinctly in these experiments is that where the same infective material is used in which the dose can, to a certain extent, be regulated, the animals all die at about the same period, indicating that the course of the disease has been very similar in all the experiments, for of the three guinea-pigs fed with raw tubercular milk, one died in 110 days, the second in 113, and the third in 116 days, a singularly consistent result when the length of time is taken into consideration, and one which can only be accounted for on the assumption that the animals received similar doses of the tubercular virus. Such equality of dosage is only attainable where the bacilli are distributed with very great regularity, as in this tubercular milk.

Action of products bacilli in producing ulceration.

Same dose of same tubercular milk apparently always followed by same results.

TABLE XXVIII.

Experiments with Tubercular Milk heated at 60° C. (140° F.) from Cow No. 20.

Time heated.	**Feeding Experiments.** Number of Animals used in Experiments.	Result with Animals that lived over 28 Days. Number of Animals.	Result.	**Injection Experiments.** Number of Animals used in Experiments.	Result with Animals that lived over 21 Days. Number of Animals.	Result.
15 minutes	6 guinea-pigs	6	Nil	3 guinea-pigs	3	**2 tubercular,** 1 nil.
30 minutes	5 do.	5	Nil	3 do.	3	**1 tubercular,** 2 nil.

Control Feeding Experiments, **3** guinea-pigs, **3 tubercular.**
Control Injection Experiments, **3** guinea-pigs, **3 tubercular.**

110 Feeding Experiments with Tubercular Milk heated to 60° C. (140° F.)

With the heated material, as far as the feeding experiments were concerned, the temperature used for the time above indicated was evidently quite sufficient to render the milk perfectly innocuous, as not one of the animals became infected though this sample of milk had proved so uniformly fatal when given in the raw state.

Control Injection Experiments.

In these injection experiments the regularity of the course of the disease set up by infection with the same dose of tubercular material is especially well brought out, for of the three guinea-pigs injected with raw milk from this cow (Part XII., Table No. XCIX., p. 223), one died on the 17th day, the second on the 18th day, and the third on the 20th day after inoculation, a most remarkable regularity when the slight differences in size and constitution and, in a corresponding degree, different resisting power of the animals to the disease are taken into consideration.

111 Injection Experiments with Tubercular Milk heated to 60° C. (140° F.)

The results of the injection experiments show that the tubercle bacilli in this milk were not rendered inactive by somewhat prolonged exposure to a temperature of 60° C., as two out of the three guinea-pigs injected with 1 c.c. of the milk maintained at this temperature for 15 minutes contracted tuberculosis, and of the three guinea-pigs injected with a similar quantity of the same milk heated at 60° C. for 30 minutes, one became infected.

Taken by themselves, these experiments would indicate that the chances of infection are diminished with almost mathematical regularity as the time of exposure to a comparatively high temperature is increased, but as will afterwards be found this can not be relied upon as holding good in any large number of cases, although where milk, whether raw or heated, is used, much more uniform results are obtained than when milk which had been purposely rendered infective by the addition of tubercular material is resorted to, and it must be assumed that the regular distribution of the infective material throughout the milk, the comparative isolation of individual bacilli, and their freedom from enclosing tissue or material contained in the milk, play an important part in determining this comparative uniformity in the results obtained.

Progressive attenuation of bacilli under action of heat.

The sterilising experiments of this series are exceedingly interesting as regards the question of progressive attenuation.

15 minutes at 60° C.

Two out of three of the animals used succumbed to tuberculosis as the result of the injection of this same milk heated up to 60° C. for 15 minutes, but they did not succumb, the one, until 40 days after the injection, the second until 80 days or twice and four times respectively, the time required to carry off a guinea-pig by tuberculosis induced by the injection of the raw milk; the third animal escaped infection altogether.

30 minutes at 60° C.

When heated at the same temperature for 30 minutes the milk proved infective to only one guinea-pig out of three injected, and here again evidence of attenuation is obtained, not only in the lower percentage of animals affected, but also in the extended course of the disease, as the single guinea-pig that developed tuberculosis was not carried off until the 72nd day.

Importance of injection experiments as determining degree of infectivity of milk. Heating.

It might appear from these experiments, if taken by themselves, that there was comparatively little danger of tuberculosis resulting from the ingestion of milk that had been heated as above, as out of all animals that were fed not one developed tuberculosis. As will be found later, however, when we come to deal with the ingestion experiments with pigs, such an argument would be entirely fallacious, and it must for the present be accepted that the injection experiments are of more value as affording the most certain information of the diminution in virulence of tubercular material than is generally acknowledged, and it can scarcely be too strongly insisted on that so long as a single animal is affected by tuberculosis on injection of the heated tubercular milk, so long must that milk be held to be dangerous, not perhaps to the perfectly healthy individual, but certainly to those in whom the alimentary tract is affected by any lesion which either interferes with the proper secretary functions of its different parts or renders any of its tissues more vulnerable to attack. We cannot, of course, gauge exactly the degree of susceptibility which the human subject exhibits towards infection from the alimentary tract, especially as this probably varies at different ages, the infant being much more susceptible than the adult. With this, however, it will be necessary to deal more in detail at a later stage of the report.

112 Feeding and Injection Experiments with Tuberculous Milk from Cow No. 25.

A similar series of experiments carried on with milk taken from Cow No. 25 are scarcely so satisfactory in so far as there were no injection experiments made with the milk heated to 60° C. for any period under 25 minutes, a point at which, from the results obtained in the first series, there is evidently great attenuation of the virus contained in tubercular milk.

TABLE XXIX.

Experiments with Tubercular Milk heated at 60° C. (140° F.) from Cow No. 25.

Time heated.	Feeding Experiments. Number of Animals used in Experiments.	Result with Animals that lived over 28 Days. Number of Animals.	Result.	Injection Experiments. Number of Animals used in Experiments.	Result with Animals that lived over 21 Days. Number of Animals.	Result.
5 minutes - - -	3 guinea-pigs -	3	Nil	...	...	...
10 minutes - -	2 do. -	2	Nil	...	...	...
15 minutes - -	3 do. -	3	Nil	...	...	...
25 minutes - -	3 do. -	3	Nil	2 guinea-pigs -	2	Nil
30 minutes - -	3 do. -	3	Nil	1 guinea-pig -	1	Nil
45 minutes - -	3 do. -	3	Nil	1 do. -	1	Nil
1 hour - - -	2 do. -	2	Nil	2 guinea-pigs -	2	Nil
2 hours - -	3 do. -	3	Nil	2 do. -	2	Nil
8 hours - -	3 do. -	3	Nil	2 do. -	2	Nil
18 hours - -	3 do. -	3	Nil	2 do. -	2	Nil

Control Feeding Experiments, **3** guinea-pigs, **3 tubercular.**

Control Injection Experiments, **3** guinea-pigs, **3 tubercular.**

Although the control experiments, both feeding and inoculation, were all of them positive, heating the milk for five minutes and upwards at the above temperature appears to have rendered it perfectly innocuous when introduced by the alimentary tract, whilst 25 minutes and upwards was quite sufficient to deprive it of its power of setting up tuberculosis, even when injected intraperitoneally. The animals in all these cases remained perfectly well, and on post-mortem examination showed no trace of tubercle in any part or organ of the body.

With milk from the same Cow No. 25 a more complete series of experiments was made, the milk being maintained at 65° C. (149° F.) for periods varying from 2½ minutes to 18 hours. The same controls, of course, serves for this series as for the above set of experiments carried on at 60° C.

TABLE XXX.

Experiments with Tubercular Milk heated to 65° C. (149° F.) from Cow No. 25.

Time heated.	Feeding Experiments. Number of Animals used in Experiments.	Result with Animals that lived over 28 Days. Number of Animals.	Result.	Injection Experiments. Number of Animals used in Experiments.	Result with Animals that lived over 21 Days. Number of Animals.	Result.
2½ minutes - -	3 guinea-pigs -	3	Nil	2 guinea-pigs -	2	Nil
10 minutes - -	—	—	—	2 do. -	2	Nil
15 minutes - -	3 guinea-pigs -	3	Nil	2 do. -	2	Nil
20 minutes - -	2 do. -	2	Nil	2 do. -	2	Nil
25 minutes - -	—	—	—	2 do. -	2	Nil
30 minutes - -	3 guinea-pigs -	3	Nil	2 do. -	2	Nil
1 hour - - -	2 do. -	2	Nil	2 do. -	2	Nil
2 hours - -	2 do. -	2	Nil	1 guinea-pig -	1	Nil
4 hours - - -	3 do. -	3	Nil	2 guinea-pigs -	2	Nil
8 hours - -	3 do. -	3	Nil	2 do. -	2	Nil
18 hours - - -	3 do. -	3	Nil	2 do. -	2	Nil

Control Feeding Experiments, **3** guinea-pigs, **3 tubercular.**

Control Injection Experiments, **3** guinea-pigs, **3 tubercular.**

It is somewhat interesting to note that an exposure to a temperature of 65° C. is quite sufficient, in this case, to render tubercular milk innocuous, though here, as in the previous experiments, it must be borne in mind that the milk was first heated up to 65° C. before the 2½ minutes commenced, and, as will be seen from the table, this means that the milk was exposed to a comparatively high temperature for a time considerably greater than that mentioned in the table. As all these experiments were, however, carried out under the same conditions, it is an easy matter to calculate in every table (Part IX., p. 158, 176, &c.) what the additional exposure would amount to. The results with the heated milk, both feeding and inoculation, were in all cases negative.

113 Feeding and Injection Experiments with Tubercular Milk from Cow No. 24.

The results obtained in the series of experiments in which the milk was heated up to 70° C. for various times were somewhat irregular, although they indicate very clearly that tubercular milk may be very virulent and can not always be readily sterilised; the limit of sterilisation, however, varies very greatly in the milk taken from different cows of which the udders are affected with tuberculosis. For example, in the milk taken from Cow No. 24 the more delicate test of injection proved that the raw milk undoubtedly contained tubercular virus as all three animals injected ultimately became tubercular. That the infective material in this milk, however, was not large in quantity, owing to the addition of a quantity of sound milk, or, because it had already been in some way attenuated, is seen from the fact that the course of the disease was much more prolonged, and certainly much more irregular, than in some of the other sets which are here considered. One of the guinea-pigs died in 38 days, a second in 57 days, and the third not having died at the end of 98 days was killed, when it was found to be tubercular.

Control injection results positive.

TABLE XXXI.

Experiments with Tubercular Milk Heated at 70° C. (158° F.) from Cow No. 24.

Feeding Experiments. **Injection Experiments.**

Time heated.	Number of Animals used in Experiments.	Result with Animals that lived over 28 Days.		Number of Animals used in Experiments.	Result with Animals that lived only 21 Days.	
		Number of Animals.	Result.		Number of Animals.	Result.
15 minutes - -	3 guinea-pigs -	3	Nil	3 guinea-pigs -	2	Nil
30 minutes - -	3 do. -	2	Nil	3 do. -	3	Nil
60 minutes - -	3 do. -	3	Nil	3 do. -	3	Nil

Control Feeding Experiments, **3** guinea-pigs, Nil.
Control Injection Experiments, **3** guinea-pigs, **3 tubercular.**

So far had this attenuation been carried, or so few were the bacilli in the milk, that the feeding experiments with raw milk gave absolutely negative results, and it was not a matter for astonishment that this milk, heated even for 15 minutes, was perfectly innocuous both as regards feeding and injection experiments. The more prolonged heating experiments, of course, gave similar negative results.

It is evident, as has already been pointed out, that the number of tubercle bacilli in the milk derived from any tubercular udder may vary from day to day, according to the amount and kind of the breaking down of the tubercular tissue in the udder, and according to the communication of the breaking-down areas with the milk ducts, the number of bacilli carried by leucocytes into the immediate neighbourhood of the ducts or into the ducts themselves, always being comparatively small.

114 Injection Experiments with Tubercular Milk from Cow No. 25.

In Table XXXII. no feeding experiments are recorded, as none were made, but exactly the same results were obtained by injection of the raw milk, all the guinea-pigs that were treated succumbing to an attack of tuberculosis. This milk was apparently more virulent, giving evidence of the presence of tubercle bacilli in considerable numbers, the animals dying, one in 22 days, and the other two in 25 days; but when this same milk was heated for times varying from 2½ up to 20 minutes at 70° C. not a single positive result was obtained.

TABLE XXXII.

Experiments with Tubercular Milk Heated at 70° C. (158° F.) from Cow No. 25.

Feeding Experiments. **Injection Experiments.**

Time heated.	Number of Animals used in Experiments.	Result with Animals that lived over 28 Days.		Number of Animals used in Experiments.	Result with Animals that lived only 21 Days.	
		Number of Animals.	Result.		Number of Animals.	Result.
2½ minutes - -	—	—	—	3 guinea-pigs -	2	Nil
5 minutes - -	—	—	—	3 do. -	2	Nil
10 minutes - -	—	—	—	3 do. -	3	Nil
15 minutes -	—	—	—	3 do. -	2	Nil
20 minutes - -	—	—	—	3 do. -	2	Nil

Control Injection Experiments, **3** guinea-pigs, **3 tubercular.**

Further Feeding and Injection Experiments with Tubercular Milk from Cow No. 25.

A further series of both feeding and inoculation experiments with this same milk heated to the same temperature, 70° C., was then carried out (Table XXXIII.).

TABLE XXXIII.

Experiments with Tubercular Milk Heated at 70° C°. (158° F.) from Cow No. 25.

Feeding Experiments. **Injection Experiments.**

Time heated.	Number of Animals used in Experiments.	Result with Animals that lived over 28 Days.		Number of Animals used in Experiments.	Result with Animals that lived 21 Days.	
		Number of Animals.	Result.		Number of Animals.	Result.
2½ minutes	2 guinea-pigs	2	Nil	2 guinea-pigs	2	Nil
5 minutes	3 do.	3	Nil	2 do.	2	Nil
10 minutes	3 do.	3	Nil	2 do.	2	Nil
15 minutes	3 do.	3	Nil			
20 minutes	3 do.	3	Nil	2 do.	2	Nil
30 minutes	3 do.	3	Nil	2 do.	2	Nil
1 hour	3 do.	3	Nil	2 do.	2	Nil
1½ hours	3 do.	3	Nil	2 do.	2	Nil
2 hours	3 do.	3	Nil	2 do.	2	Nil

Control Feeding Experiments, **3** guinea-pigs, **3 tubercular.**
Control Injection Experiments, **3** guinea-pigs, **3 tubercular.**

In this milk we have another step in the ascending scale of virulence; as both the control injection experiments and those carried on for the purpose of determining its power of inducing tuberculosis through the alimentary tracts gave positive results. It was more virulent than the milk from Cow No. 24 (which was not capable of inducing tuberculosis on being ingested), but the heating experiments show that this infective power was comparatively easily destroyed, just as in all the other experiments of this set, carried on with diluted tubercular milk previously referred to, in which case an exposure to 70° C. for two-and-a-half minutes rendered it innocuous even when introduced into the guinea-pig as an injection.

115 Experiments with Tubercular Milk from Cow No. 21.

The next set of experiments give entirely different results. These were carried ou with the milk from Cow No. 21, during the time that a large number of tubercle bacilli could be demonstrated in the sediment and solid particles.

TABLE XXXIV.

Experiments with Tubercular Milk placed *cold* **in the Steriliser* when the Thermometer in the Water registered 70° C. (158° F.)** from Cow No. 21.

Feeding Experiments. **Injection Experiments.**

Time heated.	Number of Animals used in Experiments.	Result with Animals that lived over 28 Days.		Number of Animals used in Experiments.	Result with Animals that lived over 21 Days.	
		Number of Animals.	Result.		Number of Animals.	Result.
5 minutes	3 guinea-pigs	2	Nil.	3 guinea-pigs	2	**1 tubercular.** 1 Nil.
	1 pig	1	**1 tubercular.**			
9 minutes	—	—	—	1 do.	1	Nil.
10 minutes	3 guinea-pigs	3	**1 tubercular.** 2 Nil.	4 do.	4	Nil.
	1 pig	1	**1 tubercular.**			
11 minutes	—	—	—	1 do.	1	**1 tubercular.**
12 minutes	—	—	—	1 do.	1	**1 tubercular.**
13 minutes	—	—	—	1 do.	1	Nil.
14 minutes	—	—	—	1 do.	1	Nil.
15 minutes	3 guinea-pigs	3	**1 tubercular.** 2 Nil.	4 do.	4	Nil.
	1 pig	1	**1 tubercular.**			

Control Feeding Experiments, **3** guinea-pigs, **2 tubercular,** 1 Nil.
3 pigs, 3 tubercular.
2 cats, **2 tubercular.**
1 kitten, **1 tubercular.**
Control Injection Experiments, **6** guinea-pigs, **6 tubercular.**

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* In the material used for the feeding experiments in this series, the temperature attained at five minutes was only 65°·5 C., at ten minutes 65°·5 C., and at 15 minutes 67°·3 C. The water in the steriliser was maintained at a temperature of 70° C. throughout.

The material used for injection was heated in smaller quantities, and in narrow test tubes, and therefore reached the required temperature much more rapidly and was there maintained for a longer period. Hence the greater action on the virus in the injection than in the feeding experiments in this case, with a corresponding alteration in the proportion of positive results obtained.

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116 Control Feeding Experiments.

Control experiments.

On referring to Table No. XXXIV. it will be seen that the control experiments give remarkably regular results, as out of nine animals fed (three guinea-pigs, three pigs, two cats, and one kitten), all with the exception of one guinea-pig developed tuberculosis; one of the guinea-pigs dying of tuberculosis in the comparatively short time of 81 days, showing that not only must the quantity of infective material present in the milk be large, but that it must also be extremely virulent. Of this we have evidence in the fact that the intestines in this animal were extensively ulcerated, and although the mesenteric glands remained almost normal as regards size, they were distinctly tubercular, the tissues evidently being killed before they had time to re-act to the stimulation or irritation due to the presence of these bacilli. In this animal, too, there had evidently been infection from the pharynx, as the adenoid tissue in the pharynx and glands in the neck were enlarged, the latter being distinctly tubercular.

Infection from pharynx in guinea pig.

Pigs in fected pharyn and to

As will be seen on reference to Part No. XII. (Table C., p. 223 *et seq.*), the pigs were in every instance affected from the pharynx and tonsils, whilst, on the other hand, there was comparatively little evidence of infection from the lower reaches of the intestine; the mesenteric glands were undoubtedly somewhat enlarged, and there must have been infection from this point, but in not one of the pigs, even those fed with this raw material, could any ulcerative process of the intestine be demonstrated.

117 Feeding Experiments with Tubercular Milk heated to 70° C. (158° F.).

As regards the feeding experiments with the heated milk, it may be noted that one out of each set of three guinea-pigs succumbed to tuberculosis when fed with milk subjected to the action of a temperature of 70° C. for 10 and 15 minutes respectively, whilst in the case of the three experiments carried on with the same material heated for five minutes, one died too early to show tuberculosis; the others remained absolutely free, and as these animals were not killed until 93 days after they were fed, tuberculosis can scarcely be regarded as still latent after that period; the irregularity in these results must therefore be accounted for in some other way.

All the pigs fed, one each with the same series of milk, heated for 5, 10, and 15 minutes respectively at 70° C., developed tuberculosis. Here the infection, had been set up primarily, apparently, from the pharynx, and only secondarily, or in a minor degree, from the intestine.

118 Control Injection Experiments.

On referring to the injection experiments it will be found that the material used in this series of experiments, though scarcely so virulent in the raw condition as that used in some of the other milk experiments, probably contained a large number of bacilli. Of six animals injected with the raw milk, all died from tuberculosis, one in 28 days, one in 29 days, one in 30, one in 32, and one in 33 days— all within five days— the sixth, however, living for 53 days.

119 Injection Experiments with Heated Milk.

The inoculations with this milk heated to 70° C. for five minutes gave positive results in one guinea-pig out of three, showing that in this instance—although no positive results had been obtained in the case of guinea pigs fed with milk heated at this temperature for five minutes—the milk still remained sufficiently infective to render one at least of the guinea-pigs tubercular by injection; on the other hand no positive result was obtained by injection with the same milk heated for 10 and 15 minutes, although in the raw state it had proved capable of inducing tuberculosis when ingested either by pigs or guinea-pigs.

But the same material heated for 11 and 12 minutes, and injected in quantities of $\frac{3}{4}$ c.c. induced tuberculosis in the guinea-pigs on which it was tested.

120 Remarks and Conclusions.

Several explanations may be offered of these apparently anomalous results. First of all we have the fact above referred to, that the number of tubercle bacilli varies very considerably on different days and in different samples, being especially numerous when larger numbers of flocculi or fragments are present in the milk, and less numerous when such particles are found only here and there. Then, too, the amount of milk drawn from the affected teat or teats is sometimes very much less than at others, and from both these causes fewer bacilli may have been present in one or other of the samples of milk on some occasions, and more on others. At the early stage the irregularity in the breaking down of the udder is especially well marked, and consequently the variations in the number of bacilli in the milk are equally great. In the very late stages, when suppuration sets in, the bacilli may sometimes disappear entirely for several days together, only to reappear in greater or less numbers at irregular intervals.

It cannot be assumed that tubercular milk is more difficult to sterilise for feeding experiments than ordinary tubercular material, unless it is that on account of the large amount of albuminous material contained in the milk from the tuberculous udder a protective covering is given to the tubercle bacillus or that a kind of albuminous precipitate (which carries down the tubercle bacilli) is formed. Such a precipitate, though usually taken by the animals in the feeding experiments, cannot be readily taken up into the fine syringes and pipettes that were used for making the injections. In this way the two facts may be accounted for: first, the bacilli are protected from the action of heat by an albuminous film and being taken into the alimentary tract are more capable of setting up tuberculosis than bacilli not so protected; whilst, on the other hand, this albumen, acting as a mechanical network carrying down the bacilli from the milk, leaves fewer in the fluid part which, only, can be taken up through a fine syringe or pipette. On this assumption it might be argued that the longer the heating process the greater would be the number of bacilli withdrawn from the fluid and the more difficult it would be to produce tuberculosis by injection, even when the bacilli themselves were not devitalised. This point was borne in mind in a number of the later experiments in which syringes with a larger bore than usual were resorted to in order that the more gelatinous fluid and small fragments might be drawn up and injected.

Milk not in every case heated up, preliminary to real experiment.

An additional source of fallacy in this case, which was afterwards eliminated in other sterlisation experiments, was that the milk was not in every case previously heated up to the temperature at which the experiment was to be carried on, so that the different thicknesses of glass and the slight differences in thickness of the columns of fluid used, together with the time taken to heat up the milk, would bring in factors which have to be reckoned with, but which could scarcely be calculated in determining the value of the results of the experiments. For this reason this method was afterwards rejected as being not entirely trustworthy, especially as there was a far greater possibility of error creeping in through imperfect sterilisation of a large number of tubes, than when one or two tubes only were used.

As will be seen from the table, the injection gave positive results when the milk had been heated at 70° C. for 12 minutes, and, as was afterwards found, artificial tuberculous material must be heated to 70° C. for 30 minutes before it is rendered innocuous for this method of introduction into the animal.

The discrepancy between the results obtained from feeding and inoculation experiments in this series and similar experiments carried on with artificially prepared tubercular milk, though it may be partly explained on the above assumptions, may be open to other explanations, for it must be borne in mind, as previously mentioned, that there are undoubtedly great variations in the virulence of the milk drawn from tubercular udders, such variations being due to the number of bacilli present in the milk, and also to the degenerative influences exerted on the bacilli by the tissues, and perhaps also to the processes of inflammation and suppuration which appear to exert a deteriorating influence on the bacilli which are still in the tissues of the udder, or are enclosed in the caseous degenerative material in tuberbular foci. It is evident from a study of the tables given in this section that raw milk from tubercular udders is in all cases possessed of the power of setting up tuberbular infection, even when mixed with considerable quantities of sound milk, whilst in some cases it possesses this power in a most remarkable degree. Evidence is also afforded that as the time during which any fixed temperature is brought into play for the purpose of sterilising tubercular milk is extended, proportionably greater, on the whole, is the diminution in the virulence of the milk treated.

Milk from tubercular udders undoubtedly infectious.

Heated tubercular milk gradually loses its virulence as temperature is raised and time during which milk is exposed to it prolonged.

121 TABLE XXXV.

Feeding Experiments with Tubercular Milk heated at 75° C. (167° F.), from Cow No. 25.

Time heated.	Number of Animals used in Experiment.	Result with Animals that lived over 28 Days.	
		Number of Animals.	Result.
Heated to 75° C.	2 guinea-pigs -	2	Nil.
7½ minutes -	1 guinea-pig -	1	Nil.
15 minutes -	2 guinea-pigs -	2	Nil.

Control Feeding Experiments, **3** guinea-pigs, **3 tubercular.**

TABLE XXXVI.

Feeding Experiments with Tubercular Milk heated at 80° C. (176° F.), from Cow No. 25.

Time heated.	Number of Animals used in Experiment.	Result with Animals that lived over 28 Days.	
		Number of Animals.	Result.
5 minutes -	2 guinea-pigs -	2	Nil.
10 minutes -	2 Do. -	2	Nil.

Control Feeding Experiments, **3** guinea-pigs, **3 tubercular.**

TABLE XXXVII.

Feeding Experiments with Tubercular Milk heated at 85° C. (185° F.), from Cow No. 25.

Time heated.	Number of Animals used in Experiment.	Result with Animals that lived over 28 Days.	
		Number of Animals.	Result.
5 minutes -	2 guinea-pigs -	2	Nil.
7½ minutes -	2 Do. -	2	Nil.

Control Feeding Experiments, **3** guinea-pigs, **3 tubercular.**

TABLE XXXVIII.

Feeding Experiments with Tubercular Milk heated at 90° C. (194° F.), from Cow No. 25.

Time heated.	Number of Animals used in Experiment.	Result with Animals that lived over 28 Days.	
		Number of Animals.	Result.
Heated to 90° C.	3 guinea-pigs -	3	Nil.

Control Feeding Experiments, **3** guinea-pigs, **3 tubercular.**

The experiments carried on with tuberculous milk (from Cow No. 25) heated at 75° C. (167° F.) for 7½ and 15 minutes; 80° C. (176° F.) for 5 and 10 minutes; 85° C. 185° F.) for 5 and 7½ minutes; and simply heated up to 90° C. (194° F.) over a Bunsen burner, all gave negative results and need no further description than is given in the above tables in which the general results of these experiments are detailed.

PART IX.

FEEDING AND INJECTION EXPERIMENTS (CONTROLLED BY EXPERIMENTS WITH RAW MATERIAL) WITH MILK TO WHICH MANIFESTLY TUBERCULOUS MATERIAL HAD BEEN ADDED, HEATED AT VARIOUS TEMPERATURES.

122 *Reasons for the use of Artificial Tubercular Milk.*

Supply of tubercular milk limited.

As the supply of milk from the tubercular udders of milk cows was necessarily limited, and the times at which it could be obtained somewhat irregular, it was early seen that resort to the manufacture of artificial tubercular milk would be necessary, for, although such artificial material cannot give such regular results as will the milk from tuberculous udders, it nevertheless may be very valuable as a means of carrying on a series of continuous experiments and of obtaining material under fairly constant conditions which may be submitted to heat for such periods of time as may be found necessary. It can always be obtained, and after the first few experiments had been completed the results were found to be sufficiently constant to allow of reliable deductions being drawn from the data collected from experiments in which it was used.

Use of artificial tubercular milk.

123 *Method of Procedure.*

Method of preparation.

The first thing necessary, however, was to obtain the material that was to be added to the sound milk in a sufficiently fine state of division, and after some experimentation the following plan was found to be most satisfactory for the attainment of the end in view. Whenever any tubercular organs were obtained from animals that had died as a result of experiment or from cattle that had been condemned for tubercle either at Harrow, Balham, the Metropolitan Cattle Market, or elsewhere, such parts as were suitable for our purpose were passed through a mincing machine, the "Champion" mincer, which both minces and grinds the meat, giving the most satisfactory results. After being passed several times through this machine, the minced tubercular material was mixed with a small quantity of milk, and was then pressed, by means of a large metal spoon, through a fine metal wire strainer. The part kept back by the strainer was again passed several times through the mincer. This finely divided material, which contained a large number of tubercle bacilli, was then added to a comparatively large quantity of sound milk, so as to obtain a fluid resembling milk as closely as possible.

After the milk had undergone the process of heating at the required temperature for a given period, it was found that the tuberculous material tended to settle to the bottom of the vessel and sometimes to become aggregated into comparatively large masses, it was therefore again passed through a small wire sieve, such as is used for straining tea, in order that these masses by their presence might not stop the passage of the milk through the injection syringe, and also in order that the tubercular material might be equally distributed throughout the fluid. The material which was left on the strainer, after the last straining, was in some instances added to the material used for the feeding experiments, but was seldom used as injection material, owing to the difficulty of getting it through the needle. In one or two instances, however, the material was so thick that glass pipettes and small cannulæ had to be used in place of even the large needles already described in Part VIII., p. 144, s. 107.

Human sputum sometim used.

In certain cases sputum from human consumptive patients was added to the milk in order to render it infective. Here again we were confronted with a difficulty; the amount of tenacious mucous present was often very large, and it was a somewhat difficult matter to obtain even a fairly good emulsion of the sputum in the milk. It was found, however, that by passing the tenacious sputum several times through the mincer and then carefully pounding in a mortar and adding a small quantity of milk from time to time, and finally passing it through a fine sieve, a very fair mixture was ultimately obtained, which could be used, not only for feeding experiments, but also for injection experiments if care was taken to have the needle of fairly large bore.

All app ratus n carefull sterilis

After each set of material had been minced the mincing machine and the sieve were carefully sterilised, by soaking them thoroughly in a 5 per cent. watery solution of carbolic acid, plunging them into boiling water, and then washing with cold water. The knives, forceps, and other apparatus used in mincing the meat, and the porcelain dishes used in its collection (ordinary photographic dishes were found to answer best for this purpose) were all sterilised in a similar fashion.

Relatio of these control experim to heat experi- ments.

If, from the control experiments it can be gathered that the material was sufficiently virulent to produce tuberculosis, and to give positive results in a large proportion of the cases, any method of treatment of this virulent material, such as heating, which reduces this proportion of positive results in any marked degree, must necessarily be looked upon as exerting a powerful attenuating or sterilising effect on such material.

124 EXPERIMENTS WITH ARTIFICIAL TUBERCULAR MILK HEATED TO 50° C. (122° F.).

Materi used fo prepar of artifi tubercu milk.

No. 1 Material (*see* Part XIII., Table CIII., p. 230, *et seq.*).—The tubercular material (always meaning artificial tubercular milk) used in this series of experiments consisted of 130 cc. of the juice and pulp of the organs—liver, spleen, and glands of tuberculous guinea-pigs added to 140 cc. of normal milk. The animals were fed with this material as long as it lasted; injections were also made with it during the same period.

No. 2 Material, given on the 45th day.—The second material was used both for feedings and injections, but principally for the former; it consisted of the tubercular milk from Cow No. 25. When it was used for injection 5 cc. was given to each animal.

No. 3 Material, given on the 64th day, consisted of 400 cc. of the juice and pulp of the manifestly tubercular lung of Cow No. 23, and the organs of two tubercular guinea-pigs added to 1,000 cc. of normal milk; this material was used for feeding experiments, but was not used for injections.

No 4 Material, given on the 73rd day.—400 cc. of the juice and pulp of the manifestly tubercular lung of Cow No. 18 was added to 1,000 cc. of normal milk; many of the animals were fed with this material, but it was not used for injection purposes.

Material No. 5.—This was used by itself for a separate series of experiments. It was heated to 50° C. and maintained at that temperature for periods differing from those for which the other materials were heated, and was given to both guinea-pigs and cats. It was prepared by mincing the tubercular lung of a cow, killed at the Metropolitan Cattle Market, and adding this to a quantity of sound milk.

125 All the above samples of artificial or natural tubercular milk were heated at a temperature of 50° C. for various times, some for 1 hour, and some for 2, 4, 8, 12, 24, and 48 hours respectively. As the heating was so prolonged, it was not thought necessary to heat the milk over the Bunsen burner previous to its being placed in the steriliser, but the water of the steriliser was maintained at a temperarure one or two degrees higher than that at which it was wished to keep the milk. For example, the water in the steriliser was raised to 52° C., and the milk was placed in beakers floating in this water; when the lid of the steriliser was taken off at the end of a quarter of an hour, the water still remained at 52° C., but the temperature of the milk had only risen to 49°·5 C. The following table gives the exact temperatures, attained during the experiment, taken at different periods during the heating of Material No. 1.

TABLE XXXIX.

Temperature of Milk taken during the Process of Sterilization at 50° C. (122° F.).

Time in Steriliser.	Temperature of Milk.
	°C.
15 minutes	49·5
30 minutes	49·5
1 hour	49·75
1½ hours	50
2 hours	50
4 hours	50
8 hours	52
12 hours	51

It will thus be seen that in one hour the temperature had risen to 49°·75 C., and for four hours never rose above 50° C. After which it went up a couple of degrees in the next four hours, falling again to 51° C. in the succeeding four hours.

Another example may be given. The milk from Cow No. 25 (No. 2 material) was placed in the sterilising apparatus in which the water was at 51° C.; in this case the temperature of the milk was taken every hour only, and the lid of the sterilising apparatus was not raised so frequently, nor was it kept off so long as in the previous case, with the result that there was not quite the same difference in temperature between the milk and the water that is observed in the foregoing table. These two examples may be taken as characteristic types of the temperature conditions maintained in the other three sets of material.

126 TABLE XL.

Temperature of Milk taken during the Process of Sterilisation at 50° C. (122° F.).

Time in Steriliser.	Temperature of Milk.
	°C.
1 hour	49·5
2 hours	50·5
4 hours	48·0
12 hours	50

Multiplication of feeding experiments.

In order to increase the probabilities of the animals taking tubercle (if material heated at this temperature and for these times could induce it) the feedings were multiplied, and in many instances the animals received two or more injections; it is not, however, necessary here to repeat in detail the number of feedings and inoculations and the amount each animal received, as these are set forth in Part XIII., Table CIII., p. 230, *et seq.*, in which the details of the experiments are given.

127 TABLE XLI.

Experiments with Artificial Tubercular Milk heated to 50° C. (122° F.).

Feeding Experiments. **Injection Experiments.**

Time heated.	Feeding: Number of Animals used in Experiments.	Result with Animals that lived over 28 Days.		Injection: Number of Animals used in Experiment.	Result with Animals that lived over 21 Days.	
		Number of Animals.	Result.		Number of Animals.	Result.
1 hour	3 guinea-pigs	3	**3 tubercular.**	4 guinea-pigs	4	**4 tubercular.**
2 hours	3 do.	3	**2 tubercular.** 1 Nil.	4 do.	4	**4 tubercular.**
	1 kitten	1	Nil.			
3 hours	3 guinea-pigs	3	**1 tubercular.** 2 Nil.	1 kitten	1	**1 tubercular.**
	1 kitten	1	**1 tubercular.**			
4 hours	6 guinea-pigs	6	**5 tubercular.** 1 Nil.	4 guinea-pigs	4	**4 tubercular.**
	1 cat	1	Nil.			
	1 kitten	1	Nil.			
5 hours	3 guinea-pig	2	Nil.	—		—
6 hours	3 do.	3	Nil.	1 kitten	1	**1 tubercular.**
7 hours	3 do.	3	Nil.	—	—	—
8 hours	3 do.	3	Nil.	4 guinea-pigs	4	**1 tubercular.** 3 nil.
12 hours	3 do.	2	Nil.	7 guinea-pigs	7	**3 tubercular.** 4 nil.
				1 kitten	1	Nil.
15 hours	—	—	—	3 guinea-pigs	3	Nil.
				1 kitten	1	Nil.
18 hours	—	—		3 guinea-pigs	2	Nil.
				1 kitten	1	Nil.
21 hours	—	—		3 guinea-pigs	3	Nil.
24 hours	3 guinea-pigs	3	Nil.	4 do.	4	Nil.
48 hours	3 do.	3	Nil.	3 do.	3	Nil.

Control feeding experiments, **6** guinea-pigs : 1 too early to show, **4 tubercular,** 1 nil.

Control injection experiments, **6** guinea-pigs : 1 too early to show, **5 tubercular.**

128 *Control Feeding Experiments.*

Control feeding experiments not always satisfactory

The control feeding experiments (detailed in Table CIII., Part XIII., p. 230 *et seq.*), as regards Material No. 1., are somewhat unsatisfactory, but where the three sets of material were given (Nos. 1, 2, and 3) to one animal it was found that it developed well marked tuberculosis, although the animal had to be killed at the end of 125 days in order that this might be demonstrated.

Effect of presence of large number of tubercle bacilli.

The control-feeding experiments, performed with Material No. 5, all gave positive results; this material evidently contained a large number of tubercle bacilli, as one of the animals fed died in 23 days, another in 59 days, and the third, on being killed on the 61st day, was found to be in an advanced stage of tuberculosis. All of the animals showing well marked ulceration of the intestine, the two that lived the longer times showing extensive affection of the glands, not only in the peritoneal and thoracic cavities, but also in the neck.

129 *Feeding Experiments with Heated Material.*

Evidence of attenuation by heat.

The materials Nos. 1, 2, 3, and 4 remained virulent for feeding when heated at 50° C. up to four hours, although the course of the disease set up by milk heated at this temperature is evidently somewhat prolonged, and the proportion of affected to unaffected animals becomes—for more than one hour—gradually diminished. When the fourth hour is reached, however, there is a sudden reversal of this proportion of positive to negative results, we have still more marked evidence of the diminution in virulence of the heated material. In two animals killed in 61 days after feeding, there is only slight enlargement of the Peyers patches and the mesenteric glands, though the latter are distinctly tubercular. Even in those animals that were allowed to live for 172 days the extent of the tubercular affection is not nearly so great as in the control animals.

At the end of five hours the virulent material No. 5 had entirely lost its power of setting up tuberculosis through feeding, as not a single animal out of the whole series of feedings in which this material heated to 50° C. for 5, 6, 7, 8, 12, 24, and 48 hours was used, developed the faintest trace of any tubercular lesion.

130 *Control Injection Experiments.*

Control experiments satisfactory except as regards "regularity" of results.

The control-injection experiments (*see* Part XIII., Table CIII., p. 234) with material Nos. 1 and 5 all gave positive results, tuberculosis being developed in every animal in which these materials were used, except one, which died in five days, far too early a period to allow of the development of the disease.

Due to irregularity of distribution of bacilli.

Here, as in the feeding experiments, the tubercular virus must have been distributed somewhat unequally through the medium in which it was conveyed to the animals; we have evidence of this in the absence of uniformity both as regards the course of the disease, and the time of death, the latter of which was such a marked "constant" when milk from tuberculous udders was used.

Details of results.

After being injected with Material No. 1, one animal died in 26 days; the other lived for 50 days.

After being injected with Material No. 5, one of the animals died in 16 days, not, however, in a very tubercular condition, and the other two had to be killed at the end of 40 days, in order to demonstrate that they were tubercular; in them, however, the disease was well advanced.

131 *Injection Experiments with Heated Material.*

Influence of heat on this material.

The sterilising influence of the heat to which these materials were exposed may be traced fairly readily in this series of experiments, although the fall that ensues by no means corresponds exactly and regularly with the period of heating. Taking the guinea-pigs alone, it will be found that when an animal died after an injection of tubercular milk heated for one hour or longer, one of two conditions is present, viz., when death takes place as a result of the injection of milk, heated for the comparatively short time, the disease is well advanced, even when the animal dies soon after it has been injected; whilst in the case of those animals that die at a similarly early period after being injected with milk that has been heated for a longer time, the tubercular lesions are much less extensive, more localised, and are evidently not the cause of death. It is only when animals injected with the latter material live for a much longer period, that anything like advanced and wide-spread tubercular lesions sufficient to cause death of the animal, are demonstrable.

Thus two animals injected with milk heated to 50° C. for one hour were extensively affected, and died, evidently from tuberculosis, in 63 days and 74 days respectively.

With the same milk heated for two hours the time of death varied from 63 to 104 days.

In guinea-pigs injected with the same material heated for four hours, the time of death varied from 24 days to 87 days, but in one animal that died on the 28th day, although there were small early tubercular nodules in the spleen and pancreas (none elsewhere) these were not sufficiently marked to have caused the death of the animal.

When this artificial tubercular milk had been heated for eight hours, the only animal injected with it that became tubercular was killed at the end of 117 days, when a very localised tubercular lesion was found.

Of four guinea-pigs injected with the same material heated for 12 hours, three were tubercular; one of these animals died at the end of 117 days in an advanced stage of tuberculosis, whilst the other two were killed on the same day (117 days, after the first injection), but the disease in them was found to be not so advanced as in the animal that succumbed to the disease.

Here, then, we have evidence of the progressive diminution in the virulence of the material that was heated. After this point (*i.e.*, after being heated to 50° C. for more than 12 hours), the bacilli in the artificial tubercular milk were no longer capable of successfully engaging with the tissues; though alive, they gained no foothold in the body and were unable to set up tuberculosis.

Putting the results of these experiments on guinea-pigs into tabular form we have the following almost graphic representation:—

132 TABLE XLII.

Experiments on Guinea Pigs. Artificial Tubercular Milk heated to 50° C. (122° F.).

Summary.

Time in Steriliser.	Feeding Result.	Injection Result.
1 hour	**Tubercle**	**Tubercle.**
2 hours	**Tubercle**	**Tubercle.**
3 hours	**Tubercle**	**Tubercle.**
4 hours	**Tubercle**	**Tubercle.**
5 hours	Nil	No experiments.
6 hours	Nil	**Tubercle.**
7 hours	Nil	No experiments.
8 hours	Nil	**Tubercle.**
12 hours	Nil	**Tubercle.**
15 hours	Nil	Nil.
Et seq.	Nil	Nil.

Relativ time re quired render tubercu materia innocuc a. in fee ing, and in injec experi- ments.

It will be seen from this table that in order that the artificial tubercular milk may be rendered innocuous by heating at a temperature of 50° C., the temperature must remain in action three times as long where the milk is to be used for injection experiments as when it is to be made use of for feeding experiments.

Advant of work at comp tively lo tempera tures.

The great advantage of working with a temperature so low as this is, that the sterilising process is necessarily extended over a longer period, as a consequence of which comparatively slight changes may be measured with an accuracy that is utterly out of the question when higher temperatures are used, and a regularity and uniformity of results may be obtained which we cannot hope to obtain under other conditions. Very much the same points are brought out in the following series of experiments in which the artificial tubercular milk was heated to 55° C.

EXPERIMENTS WITH ARTIFICIAL TUBERCULAR MILK HEATED TO 55° C. (131° F.).

Material used.

133 The materials Nos. 1 and 2 used in this series (Part XIII., Table CIV., p. 238 *et seq.*) of experiments correspond to Nos. 1 and 2 of the last set.

No. 1 material.—Consisted of 200 cc. of the juice and pulp of the liver, spleen, and glands of several tubercular guinea-pigs, broken down and minced in the ordinary way, and added to 350 cc. of normal milk.

Both feeding and inoculation experiments were made with this material.

No. 2 material given on the 43rd day:—Some of the later animals received another feeding and injection, the milk of Cow No. 25 being the material used.

No. 3 material given on the 68th day:—The animals were again fed with 200 cc. of the juice and pulp of the tubercular spleen, liver, and glands of guinea-pigs added to 1,200 cc. of normal milk.

No. 4 material, given on the 76th day:—Consisted of purulent material from the tubercular mesenteric glands of guinea-pigs. It was used only for some of the feeding experiments, *i.e.*, those in which the material was heated to 55° C. for 45 minutes, 3 hours, and 10 hours respectively.

No. 5 material:—A large quantity of tubercular sputum in which tubercle bacilli had been demonstrated, was mixed with milk and then heated up to 55° C. before it was placed in the steriliser; this process of heating up took four minutes. The same material was also used for a second set of animals.

The temperature of the water taken immediately after the milk was put into the steriliser in the case of No. 1 material was 54° C. None of the above materials, except No. 5 were heated to the temperature of the water before being put into the steriliser, but were put in cold, as the times during which it was to be exposed were again comparatively extended.

It will be seen from the following table that in the case of the milk No. 3 used for the feeding experiments, which undoubtedly gave tuberculosis, the temperature attained was never 55° C., the milk that was exposed for half an hour being kept at a temperature 2 degrees below 55° C., and those that were exposed for an hour and an hour and a half being heated only to within 1 degree of the nominal temperature.

134 TABLE XLIII.

Temperature of Milk No. 3, taken during the Process of Sterilisation at 55° C. (131° F.).

Time in Steriliser.	Temperature of Milk.
	° C.
30 minutes - - -	53
45 minutes - -	53·5
1 hour - - -	53·75
1½ hours - - -	54
1¾ hours - -	54
2 hours - - -	54·2
2¼ hours - -	55
2½ hours - - -	55

Time in Sterilizer.	Temperature of Milk.
	° C.
2¾ hours - -	55
3 hours - - -	55·05
3¼ hours - -	5
7¼ hours - - -	56
10 hours - -	55·75
20 hours - - -	53·5

In the case of Material No. 4, the temperature was correct up to the end of the third hour, but between the third and seventh hours the temperature fell three degrees, so that at the sixth hour it was probably two degrees below that at which we were nominally working, *see* table following:—

TABLE XLIV.

Temperature of Milk No. 4, taken during the Process of Sterilisation at 55° C. (131° F.).

Time in Steriliser.	Temperature of Milk.
	° C.
45 minutes -	55
1½ hours -	55·5
3 hours -	55
7 hours -	53
10 hours -	52
20 hours -	52

Temperature very constant.

The other materials were all maintained at a comparatively even temperature, and never varied more than half a degree from that nominally brought into play.

The following table gives the results of the experiments in this series:—

135 TABLE XLV.

Experiments with Artificial Tubercular Milk Heated at 55° C. (131° F.).

Feeding Experiments. **Injection Experiments.**

Time heated.	Number of Animals used in Experiment.	Result with Animals that lived over 28 Days.		Number of Animals used in Experiment.	Result with Animals that lived over 21 Days.	
		Number of Animals.	Result.		Number of Animals.	Result.
45 minutes -	6 guinea-pigs -	6	**3 tubercular,** 3 nil.	4 guinea-pigs -	4	**4 tubercular.**
1 hour - -	3 do -	2	**1 tubercular,** 1 nil.	—	—	—
1¼ hours -	3 do. -	2	**2 tubercular.**	—	—	—
1½ hours -	6 do. -	5	**1 tubercular,** 4 nil.	4 guinea-pigs -	2	**2 tubercular.**
3 hours - -	3 do. -	3	Nil.	7 do. -	6	**5 tubercular,** 1 nil.
4 hours - -	—	—	—	3 do. -	3	**3 tubercular.**
5 hours - -	—	—	—	3 do. -	3	Nil.
6 hours - -	—	—	—	3 do. -	3	**2 tubercular,** 1 nil.
7 hours - -	3 guinea-pigs -	3	Nil.	4 do. -	3	Nil.
10 hours - -	3 do. -	3	Nil.	4 do. -	1	Nil.
20 hours - -	3 do. -	3	Nil.	4 do. -	4	Nil.

Control Feeding experiments: **9** guinea-pigs, 2 too early to show tubercle; **6 tubercular,** 1 nil.

Control Injection experiments: **9** guinea-pigs, 2 too early to show tubercle: **7 tubercular.**

136 *Control Feeding Experiments.*

(Detailed in Part XIII., Table CIV., p. 238, *et seq.*)

Material No. 1, as in the last case, was not very virulent.

Material No. 2, though not extremely virulent, produced extensive tuberculosis in the animals that were killed 119 days after the first feeding.

Material No. 5 was much more virulent, killing two of the animals in the remarkably short time of 35 and 37 days, the third also dying at the comparatively early period of 63 days after the first feeding. The tuberculosis in these cases was extensive; there was marked ulceration of the intestines, and very general affection of the other organs and lymphatic glands, so that there could be no doubt as to the virulence of the material used in this series of experiments.

137 *Feeding Experiments with Heated Material.*

The time of death and extent of the disease in the control animals fed with material No. 5 are important factors to be borne in mind, as it was with this material that most of the experiments at the critical times, 45 minutes, 1 hour, 1¼ hours, and 1½ hours were carried on; it will be seen on reference to the tables that wherever this material heated up to 1½ hours was used the results were positive, whilst with materials Nos. 1, 2, and 3, heated for the same length of time, negative results were obtained in every instance.

No. 5 material very virulent.

It is unfortunate that this No. 5 material was not heated for a longer period, as it is just possible that the limit of time of heating at 55° C. necessary to destroy the infective power of this material had not been quite reached. We have evidence, however, as will be seen from Table CIV., that about this time the virulence fails, as out of the three last guinea-pigs experimented upon only one had become affected, the other two animals which died in 36 and 37 days respectively being absolutely normal. It may be objected that the bacilli were still dormant and had not as yet been able to multiply sufficiently to set up lesions that could be made out on most careful examination, but even if this objection could be held to be valid it must in turn be objected that the attenuation of the virulence must have been very marked indeed to allow of the virulence remaining latent for such a period.

"Latent" virulence of bacilli.

In the series of feeding experiments the progressive attenuation of the virulence, though very evident as a whole, cannot be traced with any degree of regularity or certainty from the fact that the material even in the raw state had produced such different degrees of tuberculosis in the control experiments. Indeed all that can be deduced from these experiments is that artificial tubercular milk heated to 55° C. for 1½ hours still retains the power of setting up tuberculosis when taken into the alimentary tract of a guinea-pig. There is some general evidence of attenuation in the fact that the tuberculosis developed as a result of the ingestion of this material heated for the longer period (1½ hours), is not so advanced nor so generalised as in the control experiments; moreover, the time usually required for the development of a lethal tuberculosis is considerably greater than that required when the more virulent raw material is used. In none of the feeding experiments carried on with milk heated to 55° C. for longer periods than 1½ hours (3 hours up to 20 hours) were any positive results obtained.

Evidence of attenuation

Tuberculosis developed more slowly less generalised, and lesions more fibroid in character.

138 *Control Injection Experiments.*

Fairly virulent material used in these experiments.

Of the injection experiments with control material No. 1, two out of the three animals developed tuberculosis and died, one in 36 days and the other in 50 days, the third animal succumbing in three days, much too early to show tubercle.

Material No. 2: two of the animals injected with this material died in 33 and 40 days respectively, also with well-developed tuberculosis; the third animal killed on the 13th day showed no tuberculosis, as was to be expected.

Material No. 5, which had proved so fatal to guinea-pigs at such an early date in the feeding experiments, did not appear to be so virulent as No. 2 material when injected, as of the three guinea-pigs used, one died on the 31st day, and the others not being dead on the 42nd day were killed in the lethal chamber. In them, however, the disease was very far advanced, and the animals would probably have succumbed to it in the course of a day or two.

Effect of the number of bacilli present on the nature of the lesions produced.

This interesting result indicates that in these inoculation experiments the number of bacilli may determine the extension of the disease and the date of death rather than the actual virulence of the individual bacilli, whilst in the case of feeding experiments it is possible that the amount of corrosive irritant material developed in the protoplasm of the bacilli and accompanying them may play a not unimportant part in determining whether the bacilli themselves can make their way through the epithelial layer or not, and to some extent may also modify the behaviour of the leucocytes and lymphoid cells in and around the lymphoid tissue of the intestine. It is here necessary only to draw attention to the differences observed in regard to this point in the various sets of experiments. Later it will be necessary to go into this matter much more fully in order to be able to determine with any degree of accuracy the relative importance of these modifying factors.

139 *Injection Experiments with Heated Material.*

Details of experiments.

The modification or attentuation of the virulence can be followed out fairly well in this series of experiments if the sets of materials be taken separately. For instance, with materials Nos. 1, 1 and 2, or 1, 2, and 3 combined (all of which were found in the control feeding experiments to be less virulent than No. 5) heated for 45 minutes, tuberculosis is set up by injection in from 23 to 67 days, all the animals dying from tuberculosis, and bearing evidence that the disease was advanced.

The same material heated for three hours induced death from tuberculosis in all three animals, one dying in 81 days and the other two in 97, whilst the same material heated for seven hours was totally incapable of producing tuberculosis.

With Material No. 5, heated at 55° C. for three hours, one guinea-pig out of three that died after injection, showed evidence that the disease was generalised, even when the animal succumbed at the end of 38 days, although it was much more advanced in another animal in the same set that was killed at the end of 63 days.

The same material heated for four hours had become very much modified indeed as three animals killed 63 days after injection were all found to be affected but only with very early tubercle of the mesentery.

The same material heated for five hours produced no tuberculosis when injected into guinea-pigs, but another batch of the same material heated for six hours set up a strictly localised suppuration in one animal, a condition that was probably accounted for by the fact that although the tubercle bacilli were not able to multiply, the dead bodies were present in such numbers as to be able to set up the corrosive necrotic effect which has been ascribed to the action of their dead protoplasm. Another animal in this series that died at the end of 36 days had very much the same localised condition, but in addition several necrotic patches were found in the liver; these however, resembled much more strikingly the parasitic patches described in other guinea-pigs which were certainly not tubercular. Moreover, there was no evidence of the extension of the disease beyond very slight enlargement of the mesenteric glands in which, also, no tubercular structure could be made out. Although these two cases are set down as being tubercular, the lesions are strictly localised; there is no evidence of an infective spreading power, so that the bacilli were in all probability deprived of their virulence, if not of vitality.

Action o dead bo of tuber bacilli i setting u localised necrosis suppura tion.

Collecting the results with guinea-pigs obtained from this series of experiments and arranging them in condensed tabular form, it will be seen that we obtain much the same relative results as are obtained in the set of experiments carried on with artificial tubercular milk heated at 50° C.

140 TABLE XLVI.

Experiments on Guinea Pigs with Artificial Tubercular Milk Heated to 55° C. (131° F.).

Summary.

Time in Steriliser.	Feeding.	Injection.
45 minutes	Tubercle	Tubercle.
1 hour	Tubercle	No experiments.
1¼ hours	Tubercle	No experiments.
1½ hours	Tubercle	Tubercle.
3 hours	Nil	Tubercle.
4 hours	Nil	Tubercle.
5 hours	Nil	Nil.
6 hours	Nil	Tubercle.
7 hours	Nil	Nil.
10 hours	Nil	Nil.
20 hours	Nil	Nil.

It will thus be seen that the heating at 55° C. for something between one-and-a-half and three hours is sufficient to render tuberculous material innocuous as far as infection of the alimentary tract is concerned, whilst the same material remains infective for injection when heated at the same temperature up to some period between six and seven hours. It might be expected from a comparison of the last table with this one, that if the time of six hours is the period required to render this artificial tubercular milk innocuous for injection, the period required for sterilisation when the material is to be ingested would probably be about two hours.

Importa of every addition degree i process o sterilisi milk by heat.

It is interesting to notice a feature which comes out very strikingly in the following table in the series of experiments carried on at both 50° and 55° C., *i.e.*, what an important influence the heating at the extra 5° C. exerts in increasing the activity of the sterilising effect, reducing the time required to attain the object in view at least one-half; thus bearing out in the fullest fashion what has been noted by most other observers who have taken up the question of sterilisation by heat.

These comparative results are put in tabular form.

141 TABLE XLVII.

Table showing Results obtained with Artificial Tubercular Milk Heated at 50° and 55° C.

Time in Steriliser.	Feeding.		Injection.	
	50° C.	55° C.	50° C.	55° C.
45 minutes	No experiments	**Tubercle.**	No experiments	**Tubercle.**
1 hour	**Tubercle**	**Tubercle.**	**Tubercle**	No experiments.
1¼ hours	No experiments	**Tubercle.**	No experiments	No experiments
1½ hours	No experiments	**Tubercle.**	No experiments	**Tubercle.**
2 hours	**Tubercle**	No experiments.	**Tubercle**	No experiments.
3 hours	**Tubercle**	Nil.	**Tubercle**	**Tubercle.**
4 hours	**Tubercle**	No experiments.	**Tubercle**	**Tubercle.**
5 hours	Nil	No experiments.	No experiments	Nil.
6 hours	Nil	No experiments.	**Tubercle**	**Tubercle.**
7 hours	Nil	Nil.	No experiments	Nil.
8 hours	Nil	No experiments.	**Tubercle**	No experiments.
10 hours	No experiments	Nil.	No experiments	Nil.
12 hours	Nil	No experiments.	**Tubercle**	No experiments.
15 hours	Nil	No experiments.	Nil	No experiments.
Et seq.	Nil	Nil.	Nil	Nil.

142 EXPERIMENTS WITH ARTIFICIAL TUBERCULAR MILK HEATED AT 60° C. (140° F.).

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In order to make this series especially complete, a very large number of different sets of material were used—no fewer than 15 different kinds of artificial or natural tubercular milk. Some of the guinea-pigs received as many as 10 feedings or 878 c.c. in all, extending over a period of six months, others received only a single feeding. Some of the guinea-pigs received four intra-peritoneal injections, others received three, a few two, and the remainder one, so that if even a small proportion of the materials were infective after they were maintained at a temperature of 60° C. for various periods, the animals must necessarily run a great risk of taking the disease either by feeding or by injection. (For details, *see* Part XIII., Table CV., p. 243, *et seq.*)

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Material No. 1, consisted of the juice and pulp obtained by grinding pieces of a tubercular lung (of Cow No. 12, killed at Harrow) which had been kept as fresh as possible in the ice safe. It was broken down in the ordinary way and added to a small quantity of milk. The thermometer placed in the water in the steriliser registered 60° C. before the milk was put in to be heated up to the required temperature.

Material No. 1*a*, given five days later.—This consisted of 7·5 cc. of the pulp and juice of the tubercular liver of a guinea-pig, broken down and added to 500 cc. of sound milk, the latter being at 61° C. When this mixture was put into the steriliser the water stood at 63° C.; cold water was added to bring down the temperature of the water to 61° C., and at the end of three minutes the temperature of the milk stood at 60° C., from which it did not vary more than 0°·2 C. during the time it was under observation.

Material No. 2, given on the 55th day, consisted of the pulp and juice of the tubercular organs of several guinea-pigs added to a quantity of sound milk.

Material No. 3, given on the 90th day. was milk sent by Dr. Martin from Cows Nos. 26 and 27. No tubercle bacilli could be made out, under the microscope, in this milk, and it was afterwards found that it was entirely non-infective, so that this material need not be considered as being used in the experiments.

Material No. 4, given on the 98th day.—2,000 cc. tubercular milk from Cow No. 25, plus 400 cc. ordinary milk.

Material No. 5, given on the 104th day, consisted of a mixture made up of 100 cc. of the juice and pulp of tubercular livers, spleens, and glands of guinea-pigs added to 1,600 cc. of water and 1,100 cc. of the tubercular milk from Cow No. 25.

Material No. 6, given on the 161st day, was made up of 200 cc. of the juice and pulp of spleen, lungs, liver, glands, and pleura of a pig, and the tubercular organs of several guinea-pigs, added to 1,000 cc. of sound milk.

Material No. 7, given on the 163rd day, was composed of the juice and pulp of the tubercular organs of some control guinea-pigs added to sound milk. It had been heated to 60° C., when placed in the steriliser and was maintained at that temperature throughout.

Material No. 8, given on the 168th day.—This consisted of the pulp and juice of a mass of "grapes" received from the Metropolitan Cattle Market, and the lungs, liver, spleen, and glands of a guinea-pig, mixed with sound milk. In both sets of material tubercle bacilli were demonstrated microscopically.

Material No. 9, given on the 171st day, consisted of the pulp and juice of the tubercular organs from three guinea-pigs in an advanced stage of tuberculosis, to which sound milk was added.

Material No. 10, given on the 181st day.—The pulp and juice of a tubercular human lung mixed with a large quantity of normal milk.

The next three sets of material were used especially in connexion with a series of feeding experiments carried on with cats and pigs, viz.:—

Material No. 11.—The first set in this series consisted of the juice and pulp of the tubercular lung of Cow No. 33, which was killed when in an advanced stage of tuberculosis; to this was added a large quantity of normal milk. This material took seven minutes to attain a temperature of 60° C. before being placed in the steriliser.

Material No. 12, given on the 10th day, consisting of caseous tubercular material from the same lung (kept on ice), mixed with a large quantity of normal milk, was used for another feeding for the same set of animals. This took 12 minutes to heat up before being placed in the steriliser.

Material No. 13, given on the 24th day.—Another mixture was made with the juice and pulp of a human lung (which was in an advanced stage of tuberculosis) mixed with sound milk. This material took three minutes to reach 60° C. before being placed in the steriliser.

Material No. 14.—This was used for a fresh set of injections, and was made up of the juice and pulp from the lung, of a tubercular cow, received from the Metropolitan Cattle Market, mixed with a quantity of normal milk.

All the above materials were, previous to being placed in the steriliser, heated to 60° or 61° C., in a flask, either over a Bunsen burner or in the water bath; the time taken to reach this temperature varied according to the quantity of material dealt with. On being removed from the steriliser the milk was rapidly cooled down by placing the beakers in cold water.

The following table gives, at a glance, the temperatures maintained in a few of the above specimens at different times during the process of heating.

143 TABLE XLVIII.

Temperature of Milk taken during the Process of Sterilisation at 60° C. (140° F.).

Time in Steriliser.	Number of Materials.					
	1.	2.	3.	4	5.	6.
	° C.	° C.	° C.	° C.	° C.	° C.
5 minutes	57	—	58	60	58	—
10 minutes	57	—	59	60	58	—
15 minutes	59	—	59	62	58	—
20 minutes	—	—	—	—	—	59
25 minutes	—	59	61	62	60	—
30 minutes	61	—	61	60·75	60	60
35 minutes	—	60	62	60·5	60	—
45 minutes	61	—	61	60·5	60	60
1 hour	61	—	61	60·5	60	60
2 hours	—	—	—	60	61	60
3 hours	—	—	—	60	65	60
18 hours	—	—	—	—	58	60

Several sets of material used in most cases.

As feedings or injections of this artificial tubercular milk were repeated from time to time, and as some of the animals thus received very considerable quantities of the heated artificial tubercular material, others receiving somewhat smaller quantities, and as they were not all fed with exactly the same material, different combinations being given in different cases, it could only be expected that the results obtained would not be so regular as in those cases where one set of material only was used, and especially in those cases where milk of fairly constant virulence, drawn from a tubercular udder, was used alone.

144 *Control Feeding and Injection Experiments.*

Control feeding experiments.

On examining a few of the control feeding experiments (Table CV., p. 243 *et seq.*) it will be noted that Material No. 1 is certainly of comparatively low infective power, for although when injected into one cat and three guinea-pigs, the cat and two guinea-pigs succumbed to tuberculosis, comparatively rapidly, all the feeding experiments carried on with guinea-pigs gave absolutely negative results.

Material No. 1*a* was also infective when injected, but no feeding experiments were made.

Material No. 4 was distinctly more virulent than No. 1, as five out of six guinea-pigs fed with it developed tuberculosis, and three guinea-pigs injected with it, all became tubercular.

Materials Nos. 5, 6, 8, and 14 were only tested by means of injection, but they were all sufficiently virulent to produce tuberculosis in every animal that lived long enough to be used as a test.

Material No. 10.—As this was used merely for feeding purposes, it was controlled by a couple of feeding experiments on guinea-pigs only, both the animals succumbing.

Attenua of virule

Repetitions of the feeding with these several materials after being subjected to heat, were so frequent that it is evident that if guinea-pigs could take tuberculosis at all they must contract it from some one or other of the above materials, so many of which proved to be capable of setting up tuberculosis in the raw state, and it is at once evident that if the action of heat on samples of these materials tends in any way to diminish their virulence, the table should at once show a marked diminution in the number of animals affected when fed or injected with the heated artificial milk. When guinea-pigs are used this diminution in the virulence is at once evident.

145 TABLE XLIX.

Experiments with Artificial Tubercular Milk heated at 60° C. (140° F.)

Feeding Experiments. **Injection Experiments.**

Time heated.	Number of Animals used in Experiments.	Result with Animals that lived over 28 Days.		Number of Animals used in Experiments.	Result with Animals that lived over 21 Days.	
		Number of Animals.	Result.		Number of Animals.	Result.
5 minutes	3 guinea-pigs	3	Nil.	6 guinea-pigs	5	**4 tubercular.** 1 Nil.
10 minutes	3 do.	3	**1 tubercular.** 2 Nil.	7 do.	7	**3 tubercular.** 4 Nil.
15 minutes	6 do. 1 cat	6 1	Nil. Nil.	9 do.	8	**1 tubercular.** 7 Nil.
20 minutes	3 guinea-pigs	2	**1 tubercular.** 1 Nil.	3 do.	3	**1 tubercular.** 2 Nil.
25 minutes	3 do.	3	Nil.	3 do.	3	Nil.
30 minutes	3 do. 1 cat **1 pig**	3 1 1	Nil. Nil. **Tubercular.**	6 do.	6	**3 tubercular.** 3 Nil.
35 minutes	3 guinea-pigs	3	Nil.	3 do.	3	Nil.
45 minutes	3 do.	3	Nil.	10 do.	9	**7 tubercular.** 2 Nil.
1 hour	3 do. **1 pig**	3 1	Nil. **Tubercular.**	9 do.	8	**2 tubercular.** 6 Nil.
$1\frac{1}{4}$ hours	—	—	—	3 do.	3	**2 tubercular.** 1 Nil.
$1\frac{1}{2}$ hours	—	—	—	3 do.	3	**1 tubercular.** 2 Nil.
2 hours	3 guinea-pigs	3	Nil.	6 do.	5	**3 tubercular.** 2 Nil.
8 hours	3 do.	3	Nil..	3 do.	3	Nil.
18 hours	3 do.	3	Nil.	5 do.	5	Nil.

Control Feeding Experiments, **18** guinea-pigs, 2 too early to show tubercle. 5 nil. **11 tubercular,**
1 cat, **1 tubercular.**
1 pig, **1 tubercular.**
Control Injection Experiments, **21** guinea-pigs, 2 too early to show tubercle. 1 nil. **18 tubercular.**
1 cat, **1 tubercular.**

146 *Feeding Experiments with Heated Material.*

Control experiments.

Experiments with heated milk.

Taking first the feeding experiments with milk, one is at once struck with the fact, on the right hand side of the page, where the control-feeding experiments are given (*see* Part XIII., Table CV., p. 247 *et seq.*) nearly every animal is affected; but that on the left hand side, where are recorded the experiments carried on with the heated artificial tubercular milk, there are only four cases of tuberculosis in the whole table; of these four, two are pigs, the only two pigs used in this series. All the other animals, both guinea-pigs and cats, with the exception of two guinea-pigs, escaped completely, and when it is seen that some of these guinea-pigs received as much as 880 cc. of the heated milk from 10 different sets of material, it is evident that these must have been sterilised in almost every instance by being subjected to this degree of heat for the times mentioned in the foregoing table, at any rate, as far as its action on the alimentary tract of guinea-pigs is concerned.

Large quantity of milk ingested.

One of the guinea-pigs affected developed tuberculosis after receiving 878 cc. of 10 samples of artificial tubercular milk, which had been heated at 60° C. for 10 minutes, but both the other animals in the same set escaped.

Changes chronic a fibroid in character

The same thing happened in the case of one guinea-pig that had received in all 340 cc. of three sets of tubercular material that had been heated to 60° C. for 20 minutes.

In both these cases the changes were so chronic, and so much fibrous tissue had been developed in the liver, that had not similar conditions been demonstrated in other guinea-pigs, in which there could be no doubt of the tubercular origin of the disease, these would scarcely have been recognised as cases of tuberculosis at all, especially as in neither of them could tubercle bacilli be demonstrated, even after a very careful search had been made for them. In several other animals, however, in which exactly the same conditions were observed, a single tubercle bacillus was here and there demonstrated in the newly formed tissue. Our attention is here, then, for the first time drawn to a peculiar cirrhotic condition of the liver, which was frequently met with in cases of tuberculosis, which ran a very prolonged course (invariably the result of the introduction of heated tubercular material into the guinea-pigs) a condition which corresponds much more nearly to certain fibroid conditions met with in the course of chronic phthisis in the human subject than to anything I have hitherto observed in any other tubercular animals. Here the fibroid condition is confined to the liver, and is much more frequently associated with the feeding experiments than with the injection experiments; this is in all probability to be attributed to the fact that the amount of tubercular virus absorbed is, in the former case, very much less than in the latter.

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That the material used in the above experiments still contained virus, capable, under certain conditions, of setting up tuberculosis, is brought out by the fact that two pigs fed with three sets of artificial tubercular milk, Nos. 11, 12, and 13, (3,000 cc. in all, being given to each) developed well marked tuberculosis. In the one case the material was heated for 30 minutes, and in the other for one hour. It is instructive to note that in one of these pigs, characteristic "grapes" were developed on the costal pleura, the pleura covering the ribs; in both animals the infection appears to have been primarily from the pharynx, and only secondarily from the lung, the lower part of the intestinal tract with its appendages (mesenteric glands, &c.) being involved at a still later stage.

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The materials used for these pigs were used for them alone, but on comparing the control experiments with the control experiments of the first 10 materials of this group, it will be seen that the unheated material, gave almost the same results, so that they may be looked upon as being practically identical in character.

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In this set of experiments three species of animals were for the first time used. The experiments with guinea-pigs were carried out some time before those made with pigs, and one was not prepared to find such a very great difference in the susceptibility of guinea-pigs, and pigs as was afterwards found to exist. It was thought, indeed, that by giving the wide margin of 40 minutes, that is the difference between heating for 20 minutes and 1 hour, the time limit necessary for the sterilisation of the artificial tubercular milk would be obtained, but (and this an exceedingly important point in connexion with the production of tuberculosis, not only in different animals, but even in individuals) this margin was evidently not sufficient, and as will be found in later experiments, especially in the experiments carried out at 65° C.—A much wider margin has to be allowed than anything brought out in the above table, and if there are these differences in animals, it is obvious that the most susceptible group must be taken as that with which the critical experiments which should guide us in arguing as to the danger to human beings should be made.

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There can be little doubt that a great danger, in connexion with feeding by milk, lies in the fact that the "claggy" fluid (and with it the tubercle bacilli), remains adherent to the (often abraided) epithelial surface of the tonsil, not merely that which is usually spoken of as covering the surface of the lymph of the tonsil, but also its extensions into the crypts which are surrounded by lymphoid tissue. From this coign of vantage the tubercle bacilli seem to have, in the pig, little difficulty in invading the surrounding tissues. Similar invasion from the glandular tissue of the pharynx which takes the place of the tonsils in guinea-pigs has been noted in the case of certain of those animals fed with tubercular milk, but very rarely in the case of those fed with more solid tubercular material.

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147 *Injection Experiments with Heated Material.*

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In the injection experiments, the effects of heat on artificial tubercular material may be followed much more accurately than in the feeding experiments, as here again the attenuating process may be spread over a much longer period. Some of the guinea-pigs injected with artificial tubercular milk which had been subjected to a temperature of 60° C., even for 2 hours, succumbed to tuberculosis. The amount of heat required to bring about a definite attenuation varies very greatly in different cases, bearing out very strongly what had been observed in connexion with the production of tuberculosis by different samples of milk drawn from cows in which the udders were undoubtedly tubercular, samples of which before being heated were capable of producing tuberculosis.

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It will therefore be well, in considering the results recorded in Table CV., to take a few examples of the infectivity of the separate samples of raw artificial tuberculous milk in order to determine the attenuating power exerted on the virulence by this process of heating.

And different artificial milks.

In the case of No. 4 material, for instance, all three guinea-pigs injected died of tuberculosis, one in 22 days, and the other two, three days later.

Now selecting from the table one guinea-pig which had received materials Nos. 1, 3, and 4 after they had been heated to 60° C. for 15 minutes, and which was killed 140 days after receiving the first injection or 42 days after receiving No. 4 material, the animal was still in a comparatively early stage of tuberculosis, all that was found being a single point in the liver and some slight evidence of early tuberculosis of the diaphragm; tubercle bacilli were found in the tubercular structures on the under surface of the diaphragm. In this case the heating must have had a very marked attenuating effect, even if it be assumed that No. 4 material only, was the disease producing factor.

The same holds good in two guinea-pigs injected with materials Nos. 1, 2, 3, and 4, which had been heated at 60° C. for 25 minutes, in which material No. 4 was given 51 days before the animals were killed when not a trace of tuberculosis could be found.

Another animal injected with the same materials, heated for 45 minutes, was also non-tubercular.

Two guinea-pigs injected with the same material heated for one hour, and killed 66 days after No. 4 had been given, showed no trace of tuberculosis, this being also the case with three guinea-pigs injected with this same material after it had been heated for 8 hours and 18 hours respectively.

In the same way, analysing material No. 6, we find that both control guinea-pigs which lived long enough to develop the disease died in an advanced stage of tuberculosis in 19 days, whilst using the same material heated for 20 minutes for the injection of three guinea-pigs, two remained entirely unaffected and the one that died of tuberculosis did not succumb until 140 days after receiving the first injection (Material No. 6), or 120 days after receiving the last injection (Material No. 10).

Three guinea-pigs injected with materials Nos. 6, 8, and 10, heated to 60° C. for 30 minutes, died considerably earlier than the above animal; all were found to be suffering from tuberculosis, and they must have received a large dose; one dying 34 days after receiving Material No. 6, and 14 days after receiving Material No. 10; the second 45 days after receiving Material No. 6, and 25 days after receiving Material No. 10; the third dying 54 days after receiving Material No. 6, and 34 after receiving Material No. 10. Here then there was certainly an extension of the time necessary to produce death of the animal as compared with the control experiments, though it was not so marked as one would expect from the extended time that the heating had been in operation, especially when compared with the experiment that was carried on with milk heated for 20 minutes. Heating at this temperature for 45 minutes distinctly diminishes the infectivity of this material, for although two animals died at a comparatively early period (39 and 49 days respectively) after the first injection (Material No. 6) or 19 and 29 days after the third injection (Material No. 10), a third animal of the set developed tuberculosis so slowly that it did not die until the 115th day after the first injection, or the 95th day after the third injection, and the fourth animal escaped altogether.

Prolongation of the course of the disease.

With Material No. 8 three guinea-pigs injected with the raw material died in 25, 27, and 39 days respectively after injection.

Taking as another example, Material No. 14, with which quite a different set of injection experiments was carried on; it was found that the control guinea-pigs died, one in 16 days and the other two in 40 days after injection, positive results being obtained in every case. So virulent indeed was this material, that even after it had been exposed to a temperature of 60° C. for 45 minutes it still remained so deadly that three guinea-pigs injected with it died, one in 34 and the other two in 37 days, all in an advanced stage of tuberculosis. Exposure of the artificial tubercular milk for periods beyond this time, however, is soon followed by evidence of a marked attenuating action on the virus; two animals injected with Material No. 14, heated for one hour, were both alive on the 62nd day, and when killed were found to be in very different stages of the disease, one showing a

Chronic fibroid form of tubercle resulting from injection of heated milk.

comparatively localised and chronic form of tubercle, the peculiar cicatricial tissue mentioned above being a marked feature, although in this instance the tubercle bacillus could be demonstrated in the new tissue; in the second animal the disease was neither so chronic nor so fibroid in character, and was more extensive; here, too, tubercle bacilli were found in fairly large numbers.

The same thing was observed in two animals that were killed in 62 days after they had received an injection of Material No. 14 heated for 1¼ hours; one was affected with comparatively chronic tuberculosis; in the other the disease was somewhat more advanced and was extending more rapidly, though certainly not so rapidly as in the advanced case in the previous set.

Out of three guinea-pigs also injected with Material No. 14 heated for 1½ hours, two developed no trace of tuberculosis, whilst the third, killed on the 62nd day, showed the chronic fibrous lesions with a few caseous points already described as characteristic of the action of an attenuated virus.

When the same material heated for two hours was used, all three guinea-pigs succumbed, one in 37 days with tubercle in a comparatively early stage of development, the other two, killed on the 62nd day, although distinctly tubercular, (the lesions containing tubercle bacilli which could be readily demonstrated) were affected with the chronic modified fibrous form already described.

Heating for two hours at 60° C. not sufficient in some cases to render tubercle bacilli material innocuous.

In the first series of experiments with materials Nos. 1 to 10, positive results had been obtained only up to the end of one hour, and the second series with Material No. 14 was carried out in order to determine, if possible, the limit at which the most virulent tuberculous material heated at 60° C. would remain active. It was concluded from the foregoing experiments that this limit would be found somewhere between one and two hours, and it was therefore thought unnecessary to go beyond this point with the second series, with the result, however, that with some of the material employed, even two hours was found to be insufficient for that purpose. As, however, the limit has been determined at 55° and 65° C. the limit for 60° C. may be taken as lying between these two, and as frequently being longer than two hours.

So far this series of experiments, though very instructive, must be looked upon as being in a certain sense incomplete, as the experiments carried on with milk heated at 60° C. for two hours still, in isolated cases, gave positive results, though, as already seen, heating at 60° C. for much shorter periods than two hours is in the case of many materials quite sufficient to render them innocuous, in fact in all except the most virulent material.

The following table indicates at a glance the results of the experiments carried on, and the point at which the gap above-mentioned occurs.

148 TABLE L.

Experiments with Guinea Pigs on Artificial Tubercular Milk heated at 60° C. (140° F.)

Summary.

Duration of Heating.	Feeding.	Injection.
5 minutes	Nil	**Tubercle.**
10 minutes	**Tubercle**	**Tubercle.**
15 minutes	Nil	**Tubercle.**
20 minutes	**Tubercle**	**Tubercle.**
25 minutes	Nil	Nil.
30 minutes	Nil	**Tubercle.**
35 minutes	Nil	Nil.
45 minutes	Nil	**Tubercle.**
1 hour	Nil	**Tubercle.**
1¼ hours	No experiments	**Tubercle.**
1½ hours	No experiments	**Tubercle.**
2 hours	Nil	**Tubercle.**
8 hours	Nil	Nil.
18 hours	Nil	Nil.

Both pigs fed with artificial tubercular milk heated at 60° C. for 30 minutes and 1 hour respectively became tubercular.

149 EXPERIMENTS WITH ARTIFICIAL TUBERCULAR MILK HEATED AT 65° C. (149° F.).

Materials used for these experiments.

Material No. 1 (*see* Part XIII., Table CVI., p. 252, *et seq.*) consisted of 15 cc. of the juice and pulp of the tubercular liver of a guinea-pig, broken down in a mortar and strained through fine wire gauze, added to 500 cc. of sound milk. The temperature of the water in the steriliser when the milk was put in registered 66° C.; at the end of five minutes the temperature of the water still remained at 66° and that of the milk at 64° C.

Material No. 2, given on the 62nd day, consisted of the organs of tubercular pigs treated as above and mixed with normal milk.

Material No. 3, given on the 93rd day: Skimmed tubercular milk from Cow No. 25 plus 400 cc. slightly sour normal milk.

Material No. 4, given on the 100th day: 1,800 cc. tubercular milk from Cow No. 25, to which the pulp and juice of the liver, spleen, and glands of two tubercular guinea-pigs mixed with 600 cc. of water had been added.

Material No. 5, given on the 118th day, was made up of some purulent material from the mesenteric glands of several tubercular guinea-pigs to which was added a quantity of sound milk.

Material No. 6, given on the 156th day, consisted of the tubercular organs of a pig and two guinea-pigs, broken down and added to sound milk.

Material No. 7, given on the 162nd day, consisted of the pulp and juice of a mass of "grapes" along with the lung, liver, spleen, and glands of four tuberculous guinea-pigs, all of which contained tubercle bacilli, added to a quantity of sound milk.

Material No. 8, given on the 170th day, consisted of the juice and pulp of the tubercular organs of three guinea-pigs, in all of which tubercle bacilli were demonstrated, added to a quantity of sound milk.

Material No. 9, given on the 171st day: 2,500 cc. tubercular milk from Cow No. 25, to which a quantity of sound milk was added.

Material No. 10, given on the 179th day, was made up of the juice and pulp of a tubercular lung in which were large chronic phthisical cavities at the apex, and a markedly thickened pleura; there was pigmented fibrous tissue in the upper lobe with advanced caseous and calcareous areas in the lower lobe. This after being broken down into a fine pulp was added to a quantity of sound milk.

Material No. 11, given on the 189th day, was similar to above.

Material No 12, given on the 226th day, was similar to No. 10.

Materials Nos. 13 to 17 were used for a fresh series of experiments:—Materials Nos. 13 and 14 were given with an interval of 10 days between. They consisted of the pulp and juice of the markedly tubercular portions of the lung of Cow No. 33, broken down and mixed with sound milk and heated in two litre flasks over a Bunsen burner to 65° C. (this heating process in the two cases taking 10 and 12 minutes respectively before the required temperature was reached) before being placed in the steriliser. The caseous material (No. 14) was kept at a very low temperature on the ice safe, and was apparently as sweet at the end of 10 days as it was when it was first put into the safe.

Material No. 15, given on the 24th day, consisted of tubercular human lung broken down and mixed with normal milk.

Material No. 16, was given on the 29th day.—It consisted of the sputum from two cases of advanced phthisis (one of which contained very many tubercle bacilli, the other a large number) broken down in a mincing machine and in a mortar and passed through a sieve as previously described and then mixed with normal milk. It took four minutes to heat up to 65° C. before being placed in the steriliser.

Material No. 17, was given on the 32nd day.—It was made up of the pulp and juice of a tubercular udder from the Metropolitan Cattle Market, and of a mass of "grapes" mixed with sound milk.

All the above were heated to 65° C. previous to being placed in the steriliser.

Temperatures at which these Artificial Tubercular Milks were Maintained.

150 In the following table are given the exact temperatures obtained in four of the samples of material used in the 65° C. set of experiments, they serve as samples for the whole 17 materials; the later ones were even more regular than those of the four here recorded, as more experience of the capabilities of the steriliser was gradually gained.

TABLE LI.

Temperatures at which Materials Numbers 1, 2, 3, and 4 were maintained in the Steriliser during this Series of Experiments.

Time in Steriliser.	Number of Materials.			
	1.	2.	3.	4.
	° C.	° C.	° C.	° C.
2½ minutes	—	65	—	65
5 minutes	64	65	64	65
10 minutes	65·5	66	65	64
15 minutes	65	65	65	64
20 minutes	66	65	65	66
25 minutes	65·5	65	65	65·5
30 minutes	64·6	65	65	65·5
1 hour	—	65	65	66
2 hours	—	—	65·5	64
4 hours	—	—	—	65
8 hours	—	—	66	—
18 hours	—	—	65	—

The temperature during the heating of the other materials never varied beyond the limits recorded in the above table.

151 SUMMARY OF RESULTS.

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In the following tabular record of the experiments it will at once be seen that the results obtained in both feeding and inoculation experiments, gave a longer time as that necessary for the exposure of the milk to the temperature of 65° C. in order to render the tuberculous material innocuous than any indicated as necessary in the last series of experiments, in which the milk was heated to 60° C. One explanation of this fact is, in the case of the injections, that in the 60° C. series there was a long gap between the two hours and eight hours in which no experiments were carried on, but this, of course, does not serve to explain the results obtained in the feeding experiments.

Explanations suggested.

Not merely accidental or due to failure of method.

Although it might, at first sight, appear that these results were due merely to accidental error of experiment during the process of heating, a more careful consideration of the tables will show that such an explanation is not sufficient, as in that case one would expect to meet with accidental cases occurring in the animals fed with material that had been exposed for a much longer time at the lower temperature, but as will be found on reference to the table, all the doubtful results occur in those experiments carried on with milk heated for periods which may be spoken of as the lower and intermediate points—that is between 2½ minutes and three hours.

Other factors to considered

The factors of the presence of a large number of bacilli, of the presence of a coagulable material or solid particles in the milk, in which the tubercle bacilli may be more or less protected against the action of the heat, may, as already pointed out, play a most important part in determining the ultimate infectivity of the milk, especially when it is remembered that in guinea-pigs, just as in human beings, there must be periods and conditions when the susceptibility of the animal to infection may, on the one hand, be very much increased or, on the other, diminished. As, however, these factors all come into play in the other series of experiments, these, at first sight, anomalous results can only be put down to some difference in the virulence of the materials used in the 60° and 65° C. sets of experiments.

152 TABLE LII.

Experiments with Artificial Tubercular Milk, heated at 65° C. (149° F.)

Time heated.	Feeding Experiments. Number of Animals used in Experiments.	Result with Animals that lived over 28 Days.		Injection Experiments. Number of Animals used in Experiments.	Result with Animals that lived over 21 Days.	
		Number of Animals.	Result.		Number of Animals.	Result.
Heated to 65° C.	3 guinea-pigs	2	Nil.	3 guinea-pigs	2	**2 tubercular.**
2½ minutes	3 do.	3	Nil.	8 do.	8	**1 tubercular.** 7 Nil.
5 minutes	3 do.	2	Nil.	8 do.	7	**3 tubercular.** 4 Nil.
10 minutes	4 do.	4	**1 tubercular.** 3 Nil.	6 do.	6	**3 tubercular.** 3 Nil.
	1 kitten	1	Nil.			
15 minutes	5 guinea-pigs	5	Nil.	10 do.	10	**2 tubercular.** 8 Nil.
20 minutes	3 do.	3	**1 tubercular.** 2 Nil.	8 do.	8	**2 tubercular.** 6 Nil.
	1 kitten	1	Nil.			
	1 pig	1	**Tubercular.**			
25 minutes	3 guinea-pigs	3	**1 tubercular.** 2 Nil.	6 do.	6	Nil.
30 minutes	4 do.	4	Nil.	10 do.	10	**4 tubercular.** 6 Nil.
	1 kitten	1	Nil.			
40 minutes	**1 pig**	1	**Tubercular.**			
45 minutes	3 guinea-pigs	3	Nil.	7 do.	7	**3 tubercular.** 4 Nil.
	1 kitten	1	Nil.			
1 hour	3 guinea-pigs	3	**1 tubercular.** 2 Nil.	9 do.	9	**2 tubercular.** 7 Nil.
1½ hour	—	—	—	3 do.	3	Nil.
2 hours	3 guinea-pigs	2	Nil.	7 do.	7	**2 tubercular.** 5 Nil.
3 hours	—	—	—	6 do.	6	**1 tubercular.** 5 Nil.
4 hours	3 guinea-pigs	3	Nil.	3 do.	3	Nil.
8 hours	3 guinea-pigs	3	Nil.	3 do.	3	Nil.
18 hours	6 guinea-pigs	6	Nil.	3 do.	1	Nil.

Control Feeding Experiments, **15** guinea-pigs, **7 tubercular,** 6 Nil, 2 too early to show tubercle. **1** cat, **tubercular. 1** kitten, **tubercular. 1 pig, tubercular.**

Control Injection Experiments, **17** guinea pigs, **13 tubercular,** 1 Nil, 3 too early to show tuberculosis.

153 *Control Feeding Experiments.*

Control materials virulent.

It will be seen from the control feeding experiments that pigs, cats, and guinea-pigs were all affected by one or other of the materials used. Of materials Nos. 1 to 12 it will be seen, on reference to the column on the right-hand side of Table CVI., Part XIII., p. 252 *et seq.*, that some at least invariably produced tuberculosis when ingested by guinea-pigs, although in certain cases the disease was not of a very acute type.

154 *Feeding Experiments with Heated Material.*

Only four of animals fed with heated milk affected.

On examining the column on the left-hand side of the same table, it is seen that the four guinea-pigs that contracted tuberculosis as the result of feeding with this heated material were all fed with most of the materials Nos. 1 to 12. In the first two (*see* pp. 253–255), one from each set, fed with milk heated for 10 and 20 minutes, all these materials were used, with the exception of Nos. 5 and 6. In the second two cases the positive results were obtained in guinea-pigs fed with milk that had been heated for 25 minutes and 1 hour respectively, and here the whole 12 materials were used.

Course of disease much prolonged in these cases.

The chief point to note in connexion with all four positive cases is the prolonged course of the disease as gathered first from the late date of death after the first feeding; and, secondly, from the chronic character of the tubercular lesions met with in all the animals.

After being fed with artificial tubercular milk heated for 10 minutes at 65° C., one guinea-pig out of four became tubercular; it died on the 30th day after the last feeding, or 76 days after the first feeding.

After being fed with similar milk heated at 65° C. for 20 minutes, one guinea-pig out of three died from tuberculosis. This animal succumbed 173 days after the first feeding, and 2 days after receiving No. 8 material, which latter, therefore, could have had no influence in producing the disease. Here we have evidence of a very prolonged tubercular process, first of all in the presence of the caseo-calcareous nodule in the deeper layers of the mucous membrane of the small intestine; and, secondly, in the fibrous nature of the lesions in certain other organs. It is evident in this case that the heated material was capable, under certain conditions, of setting up tuberculosis, and the late date at which the other animals died is therefore all the more significant.

Chronic character of the disease.

One guinea-pig out of three fed with artificial tubercular milk, heated at this temperature for 25 minutes, died on the 253rd day, or 28 days after the 12th feeding. This is also an exceedingly interesting case, as in the animal is found evidence, not only of an infection of long standing, but also of a more recent infection. The tubercle in the liver, for example, is well advanced; there are well marked caseous areas; miliary tubercles are found in the lung, and the glands in the neck and under the jaw are all affected, evidently as the result of a long standing process; but in the intestine we get evidence of a more recent affection of the mucous membrane in the form of small ulcers, such as so frequently occur in cases of phthisis in the later stages, and which are said to be due to the infection of the mucous membrane by the swallowed tubercular sputum, but which, in this case, may be due to the later feedings of artificial tubercular milk, though, on the other hand, it may be due to the infection by breaking down tubercular tissue.

The fourth animal that died was one of a set of three that had been fed with milk heated for one hour; it died 13 days after the twelfth feeding, or 238 days after receiving a feeding of No. 1 material, the former of these feedings could not, however, have had any effect in producing the firm, hard, tubercular lesions which were met with not only in the liver but in the other organs of the body.

No positive feeding results with artificial tubercular milk heated to 65° C. for more than an hour.

In not one of the feeding experiments with guinea-pigs was there any tuberculosis developed as the result of the ingestion of material that had been heated for a longer period than one hour.

Some of the pigs and cats were fed with a different series of materials. Material No. 13 was given raw to a pig, as a control experiment; it produced tuberculosis. One cat, fed with raw material No. 10, and one kitten, fed with No. 16 material, became tubercular. Guinea-pigs fed with raw materials, Nos. 10 and 11, also developed tuberculosis, and of three guinea-pigs fed with material No. 15, two developed tuberculosis, whilst the other remained unaffected, at the end of 56 days in the one case, and at the end of 75 days in the other.

One kitten fed with artificial tubercular milk, Nos. 14, 15, 16, and 17, heated to 65° C. for 10 minutes remained perfectly healthy, as did also two other kittens fed with materials Nos. 14, 15, 16, and 17, heated to 65° C. for 20 minutes and 30 minutes respectively.

Pig affec through tonsil an pharynx.

One pig, fed with materials No. 14 and 15, heated to 65° C. for 20 minutes, developed most advanced and generalised tuberculosis; the disease in this as in most of the other pigs appearing to invade the organism from the pharynx; the extensive nature of the disease will be seen on referring to Table CVI., Part No. XIII., p. 254.

"Artifici grapes in pig.

Another pig, fed with the same artificial tubercular milk, Nos. 14 and 15, heated for 40 minutes, also became markedly tubercular, and it must be noted that in this case well defined "grapes" were scattered over the chest wall. The advance of the disease appears, however, to have been rather from the intestine than from the pharynx; the glands in the neck though enlarged were not tubercular, nor was there any marked evidence of infection from the lower reaches of the alimentary canal, beyond some nodules in the spleen and liver, from which extension seems to have taken place to the diaphragm, and it may be thence to the root of the lung, the pleura, and the lung itself. It should be noted, however, that the cœliac glands and those at the hilus of the liver, and the mesenteric and mesocolic glands were all tubercular.

Artificial tubercul milk affe through pharynx pig as lo as it affec guinea pi through injection into perit neal cavi

This artificial tubercular milk then still remained infective, even when heated to 65° C. for 40 minutes. Here the condition of infection from the pharynx is apparently much more like those occurring in inoculation and injection experiments than in the feeding experiments with guinea pigs; up to this point, indeed, every pig that has been fed has contracted the disease, and, with the single exception above mentioned, primarily through the tonsils and pharynx.

Do a few guinea pigs also contract tuberculo through t adenoid tissue of t pharynx.

It will be noticed, that in all the guinea-pigs in the series in which the heated material produced tuberculosis, even at a comparatively late date, the glands in the neck and in the axilla are much more affected than in any of the other series of experiments yet met with. It may be of course that this is due simply to an extension of the disease from other parts of the body, but where the upper cervical glands and submaxillary and submental glands are specially affected, or where, as in one case, (?) they alone are affected, it is clearly possible that the disease may have extended rather from the pharynx than from the intestine, in which case, as has already been pointed out in the pig, the degree of attenuation must approximate more closely to that required for injection than that required for feeding. Whether wounds of the tonsils or slight inflammatory or catarrhal conditions predispose to infection from this point it is at present difficult to say, though, from analogy, one would expect that such conditions would play an important part in the process. In the case of the pig, where such things as fine straws, hairs, chaff, and the like may often be squeezed from the small openings or crypts in the tonsils, a continual condition of abrasion may be almost safely presupposed in every animal fed, owing to the kinds of food to which pigs have access.

Do wound or abrasio of tonsils predispos to tuber-cular infe tion?

The fragments were always found in the crypts of the tonsils of the pigs, but they could not be made out in the pharyngeal adenoid tissue of the guinea-pig. Where straw could find its way milk could easily follow, and with the milk the solid particles contained in it.

In the case of the guinea-pig, such abrasion cannot occur in nearly the same number of cases, and it is only now and then, and under peculiar conditions, that we should expect to find it.

155 *Control Injection Experiments.*

Control ex periments.

Materials 1, 5, 6, 7, 12, and 13. It is found that amongst these we have materials which, on injection, produce tuberculosis in very varying degree. For example, three guinea pigs, injected with Material No. 1, died from tuberculosis in 39, 41, and 96 days respectively. The guinea-pigs injected with No. 5 material also died from tuberculosis in 58 and 80 days respectively. With No. 6, of three guinea-pigs injected, two died in 19 days with well-marked tuberculosis, whilst the third escaped altogether. With No. 7 material three guinea-pigs died from tuberculosis, one each in 26, 27, and 39 days after injection. With No. 12 material, one animal killed in 89 days after the injection was found to be markedly tubercular, and of two animals injected with Material No. 15, one died in 31 and the other in 60 days, both being tubercular.

Injection Experiments with Heated Material.

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156 The first evidence we get of any prolongation of the course of the disease following the injection of these materials, is after they have been heated at 65° C. for 10 minutes, when it was found that only one animal, out of three injected, developed tuberculosis, and that this one did not die until the 134th day. This animal received materials Nos. 1, 2, and 3, and it is quite possible that it may have contracted the disease from either No. 2 or 3; still we have in any case evidence of an attenuating influence by the prolonged heating on the infectivity of the virus in the smaller number of animals injected with this material that succumbed.

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One animal injected with materials Nos. 6, 7, 10, and 11, heated to 65° C. for 20 minutes, died 53 days after receiving the first injection, which it will be remembered produced tuberculosis in 19 days in both of the control animals.

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Then again, materials, Nos. 1, 2, 3, 7 and 10, heated to 65° C. for 30 minutes, injected into two guinea-pigs, proved fatal to one at the end of 213 days, and to the other at the end of 215 days after the first injection, or 34 and 36 days after the last injection. Here also it must be accepted that we have strong evidence of attenuation. We have evidence of the same process of attenuation in the experiments made with milk heated at 65° C. for 45 minutes and one and two hours respectively.

Material No. 15, which killed the control guinea-pigs in 31 and 60 days respectively, when heated to the above temperature for three hours, still killed one animal out of three in 74 days, the other two remaining unaffected. The milk in every experiment in which the heating was carried on beyond three hours at this temperature gave absolutely negative results.

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It will be noticed that, in addition to prolonging the course of the disease in those animals that succumbed to tuberculosis, a very large proportion of those injected escaped entirely, and nothing can be more suggestive than a glance down the two columns of Table CVI. (Part XIII., p. 252, *et seq.*), the controls being placed on the right hand side of the page, the heating experiments on the left. The difference in the number of animals affected is at once very evident.

The following table gives at a glance the positive results obtained in this series of experiments:—

157 TABLE LIII.

Experiments on Guinea Pigs with Artificial Tubercular Milk heated at 65 C.° (149° F.)

Summary.

Time in Steriliser.	Feeding.	Injection.
Heated to 65° C.	Nil	**Tubercle.**
2½ minutes	Nil	**Tubercle.**
5 minutes	Nil	**Tubercle.**
10 minutes	**Tubercle**	**Tubercle.**
15 minutes	Nil	**Tubercle.**
20 minutes	**Tubercle**	**Tubercle.**
25 minutes	**Tubercle**	Nil.
30 minutes	Nil	**Tubercle.**
45 minutes	Nil	**Tubercle.**
1 hour	**Tubercle**	**Tubercle.**
1½ hours	No experiments	Nil.
2 hours	Nil	**Tubercle.**
3 hours	No experiments	**Tubercle.**
4 hours	Nil	Nil.
8 hours	Nil	Nil.

To afford additional facility for comparing the times at which positive results were obtained in 60° and 65° C. sterilisation experiments, the following combined table is given:—

158 TABLE LIV.

Table showing Results obtained with Artificial Tubercular Milk heated at 60° and 65° C.

Time in Steriliser.	Feeding.		Injection.	
	60° C.	65° C.	60° C.	65° C.
Heated to	No experiments	Nil.	No experiments	**Tubercle.**
2½ minutes	No experiments	Nil.	No experiments	**Tubercle.**
5 minutes	Nil	Nil.	**Tubercle**	**Tubercle.**
10 minutes	**Tubercle**	**Tubercle.**	**Tubercle**	**Tubercle.**
15 minutes	Nil	Nil.	**Tubercle**	**Tubercle.**
20 minutes	**Tubercle**	**Tubercle.**	**Tubercle**	**Tubercle.**
25 minutes	Nil	**Tubercle.**	Nil	Nil.
30 minutes	Nil	Nil.	**Tubercle**	**Tubercle.**
35 minutes	Nil	No experiments.	Nil	No experiments.
45 minutes	Nil	Nil.	**Tubercle**	**Tubercle.**
1 hour	Nil	**Tubercle.**	**Tubercle**	**Tubercle.**
1¼ hours	No experiments	No experiments.	**Tubercle**	No experiments.
1½ hours	No experiments	No experiments.	**Tubercle**	Nil.
2 hours	Nil	Nil.	**Tubercle**	**Tubercle.**
3 hours	No experiments	No experiments.	No experiments	**Tubercle.**
4 hours	No experiments	Nil.	No experiments	Nil.
8 hours	Nil	Nil.	Nil	Nil.

159 EXPERIMENTS WITH ARTIFICIAL TUBERCULAR MILK HEATED TO 70° C. (158 F.)

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Material No. 1 (*see* Part XIII., Table CVII., p. 262, *et seq.*) consisted of the juice and pulp of the tubercular lung of Cow No. 12 added to normal milk.

Material No. 2, given on the 61st day, consisted of the juice and pulp of the tubercular liver, spleen, and lung of several guinea-pigs added to normal milk.

Material No. 3, given on the 103rd day. The tubercular milk of Cow No. 25 was used for injections, and 300 cc. of this same milk added to the tubercular juice and pulp of the tubercular organs of guinea-pigs added to sound milk was used for the feeding experiments.

Material No. 4, given on the 144th day. It consisted of the tubercular milk from Cow No. 25 added to a quantity of normal milk. This material took five minutes to heat up to 70° C. before being placed in the steriliser.

Material No. 5 was given on the 159th day. It consisted of 2,700 cc. tubercular milk from Cow No. 25 added to 1,300 cc. normal milk. This took seven minutes to heat up to 70° C. over the Bunsen burner; it was then placed in the steriliser.

Material No. 5*a*, given on the 165th day, consisted of the tubercular organs of a pig and several guinea-pigs added to sound milk.

Material No. 6, given 170th day. This consisted of the juice and pulp of the spleens, livers, lungs, and glands of three tubercular guinea-pigs, added to sound milk. This artificial tubercular milk required five minutes to become heated up to 70° C. over a Bunsen burner before it was placed in the steriliser.

Material No. 7 was given on the 187th day. It consisted of the juice and pulp of a tuberculous human lung added to sound milk.

Material No. 8, given on the 196th day, was made up of the juice and pulp of a tuberculous human lung added to sound milk. This material took seven minutes to attain a temperature of 70° C. when heated over the Bunsen burner.

Material No. 9 was given on the 207th day. It consisted of the juice and pulp of the tubercular lung and glands of Cow No. 25, added to a quantity of sound milk. This material took five minutes to heat to 70° C. in the water bath, previous to the commencement of the heating in the steriliser.

Material No. 10, given on the 215th day, was similar to the above.

Material No. 11, given on the 218th day, consisted of the juice and pulp of a tubercular human lung added to sound milk. The heating-up process in this instance took nine minutes.

The three following materials were used for feeding pigs only, except for one set of guinea-pigs, which were fed with No. 13 material simply heated to 70° C. No. 9 material was also used for feeding pigs. The time of feeding extending over five weeks from the time that No. 9 was first given until the time that No. 14 was used up.

Material No. 12 consisted of the juice and pulp of the tubercular lung of Cow No. 33 mixed with a quantity of normal milk. The heating up process took 12 minutes.

Material No. 13. Similar material to above. The heating up process took 10 minutes.

Material No. 14 consisted of the juice and pulp of the tubercular udder from Cow received from Birkenhead, added to a quantity of sound milk.

All the above materials were, previous to the commencement of the sterilisation process, heated up to 70° C., the times that this required of course varying according to the amount of material being treated.

The following table gives the temperature attained by the milk at different periods of the heating:—

160 TABLE LV.

Temperatures at which Materials, Numbers 3 and 6, were maintained in the Steriliser during the Process of Sterilisation.

Time in Steriliser.	No. of Materials.		
	No. 3 (Injection).	No. 3 (Feeding).	No. 6.
	° C	° C	° C
2½ minutes -	—	—	69·5
5 minutes -	65	—	69
10 minutes -	67	69·5	70
15 minutes -	68	70	70
20 minutes -	69	71	70
30 minutes -	69	70	70
1 hour - -	70	70	70
1½ hours -	—	70	70
2 hours - -	—	71·5	70

161 TABLE LVI.

Experiments with Artificial Tubercular Milk heated at 70° C. (158° F.)

Feeding Experiments. Injection Experiments.

Time heated.	Feeding Experiments: Number of Animals used in Experiments.	Result with Animals that lived over 28 Days.		Injection Experiments: Number of Animals used in Experiments.	Result with Animals that lived over 21 Days.	
		Number of Animals.	Result.		Number of Animals.	Result.
Heated to 70° C.	6 guinea-pigs -	5	Nil.	4 guinea-pigs -	4	Nil.
2½ minutes -	3 do. -	3	Nil.	10 do. -	10	**2 tubercular.** 8 nil.
5 minutes -	5 do. -	5	**1 tubercular.** 4 nil.	9 do. -	9	**1 tubercular.** Nil.
7½ minutes -	**1 pig** -	1	**1 tubercular.**	—	—	—
10 minutes -	5 guinea-pigs -	5	Nil.	9 guinea-pigs -	9	**3 tubercular.** 6 nil.
15 minutes -	3 do. -	3	Nil.	10 do. -	8	**1 tubercular,** 7 nil.
	1 kitten - -	1	Too early to show tubercle.			
	1 pig -	1	**Tubercular.**			
20 minutes -	3 guinea-pigs -	3	Nil.	9 do. -	8	Nil.
30 minutes -	3 do. -	3	Nil.	7 do. -	6	**2 tubercular.** 4 nil.
	1 kitten - -	1	Nil.			
	1 pig -	1	Nil.			
45 minutes -	3 guinea-pigs -	2	Nil.	4 do. -	4	Nil.
	1 pig - -	1	**Tubercular.**			
1 hour - -	3 guinea-pigs -	3	Nil.	6 do. -	4	Nil.
1½ hours -	3 do. -	3	Nil.	3 do. -	3	Nil.
2 hours - -	3 do. -	3	Nil.	5 do. -	5	Nil.

Control Feeding experiments, **21** guinea-pigs, **12 tubercular,** 5 nil, 4 too early to show tubercle. **1** cat, **tubercular, 2** pigs, **2 tubercular.**

Control Injection experiments, **15** guinea-pigs, **12 tubercular,** 2 nil, 1 too early to show tubercle.

Control Feeding Experiments.

Control experiments.

162 In this series the control feedings experiments gave somewhat irregular results, but it is evident on reference to table LVI. (also Part XIII., Table CVII., p. 262, *et seq.*), that much of the material that was used was sufficiently virulent to produce tuberculosis with very great certainty, either by feeding or by injection, in some instances causing death at a comparatively early period.

Materials very unequal in effect of setting up tuberculosis.

Taking first the control feeding experiments with Material No. 1, it is found that it was not sufficiently virulent to set up tuberculosis by feeding, but of course this could not be determined for some time after the material was used; for statistical purposes it may be left out of account entirely in reading the table, especially when as will afterwards be noted, only one animal out of three injected with this material developed tuberculosis.

Material No. 2 was much more virulent, as of two guinea-pigs out of three that lived long enough to allow of the development of the disease, both when killed on the 119th day after feeding showed ulceration of the intestine and well-marked tuberculosis.

Material No. 7 was not so virulent as the above (No. 2), as of the two guinea-pigs that lived only one became tubercular; this animal, however, died on the 129th day showing marked ulceration of the intestine. One cat fed with the same material developed tuberculosis in two of the mesenteric glands; the animal was killed on the 77th day, when some caseo-calcareous nodules were found in the above position, and on microscopic examination numerous tubercle bacilli were demonstrated in and around these areas.

Material No. 8.—In this set two of the control animals died too early to show tuberculosis; the third, which lived for 33 days, was evidently tubercular, though the process was by no means advanced.

Material No. 9.—All three animals fed became affected, one dying on the 33rd day; the other two were killed on the 56th day. It is interesting to notice that in the two cases where the disease was far advanced on the 56th day there had evidently been some extension of the disease from the adenoid tissue of the pharynx or mouth, as the glands under the jaw and in the neck were all greatly enlarged and distinctly tubercular.

Extensio of tuberc from pharyng adenoid tissue in guinea pigs, Material No. 11.—Two out of the three guinea-pigs fed became tubercular. On the 104th day the animals were killed, when evidence of infection from the pharynx, but comparatively little of infection through the intestine was met with; if this latter has occurred it has evidently occurred at a very different (probably later) period. In this set of animals we have a most marked example of the irregularity of the results that can be obtained even with material that undoubtedly contains tubercle bacilli, one of the three animals escaping entirely, the other two developing most characteristic tubercular lesions. It would appear, however, that in this case the virulence of the material or its quantity may have been in some way modified in so far as it did not affect the lower part of the intestinal tract nearly so markedly as the structures around the pharynx, the evidence of a process somewhat similar to that met with in the pig, being marked, and as already pointed out, resembling the scrofulous condition met with in children in whom the glands of the neck and throat may become enormously enlarged, although the lower reaches of the intestinal tract are completely unaffected. That there was also affection from the alimentary tract even in this case, although there was no ulceration of the intestinal canal, is evident from the condition of the mesenteric and mesocolic glands, the spleen, and the liver, in which, however, the tubercular process was not nearly so marked as in most of the other control experiments.

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Of the two **pigs** used in these control experiments one was fed with materials Nos. 8, 9, 11, and 14; this animal was killed on the 117th day, and well-marked tuberculosis, evidently spreading from the pharynx, was found; the intestines showed no ulceration but the mesenteric, mesocolic, and cœliac glands were all enlarged and tubercular. The other pig fed with Material No. 12 died in 42 days, and although here, as in the other cases in which pigs were fed, there was marked affection of the tissues surrounding the pharynx, ulceration in the lower reaches of the intestine was also a very prominent feature. The number of tubercle bacilli in the tissues in this case was very great indeed, and there had evidently been a very general infection of the glands and organs surrounding the alimentary tract, from which point the dissemination of the disease had progressed very rapidly indeed, carrying the animal off at a comparatively early date.

Feeding Experiments with Heated Material.

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163 Of the 40 guinea-pigs fed with tubercular material heated to 70° C., for various periods up to two hours, only one became tubercular. These animals had been fed with materials Nos. 9, 10, and 11 heated up to 70° C. for five minutes, so that we must look on such materials as being capable of setting up tuberculosis in guinea-pigs, though this cannot be of frequent occurrence, after five minutes heating at 70° C.

When, however, we come to consider the experiments with **pigs**, the attenuation of the activity by heating at 70° C. is seen to be less efficacious than has been generally supposed, as of the four pigs fed with material heated to 70° C. for 7½, 15, 30, and 45 minutes respectively, two developed well-marked tuberculosis; in a third animal fed with milk heated for 45 minutes, the disease was not so far advanced; the fourth did not develop tuberculosis. In the case of the animals fed with milk heated for 7½ minutes the disease evidently extended from the pharynx. In the pig fed with milk heated for 15 minutes the pharyngeal origin could not be traced, both the liver and spleen were affected, and the lungs also showed marked tuberculosis, the bronchial and posterior mediastinal glands were caseous, having been apparently affected before the lungs; the other glands and organs of the body were normal. In this case the infection must have taken place from the lower part of the alimentary canal, as there was not the slightest evidence of the presence of pharyngeal tubercle.

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The pig fed with milk heated to 70° C. for 30 minutes did not develop tuberculosis, but was affected with a peculiar form of bacterial necrosis of the stomach and of the cæcum, which was evidently the result of infection with a bacillus having a somewhat similar action to that of the organism described as setting up bacterial necrosis in guinea-pigs. For description of this condition, see explanation of Figs. 10 and 47, Plates V. and XX.

The pig fed with the same material heated to 70° C. for 45 minutes, and killed on the 117th day, showed early tubercle of the bronchial and mediastinal glands, but this animal may possibly have contracted the disease through the respiratory tract. It is difficult, however, to account for such a method of infection in this case as the greatest care was taken to prevent any such mode of infection; still from the site of the tubercle, and from the late stage, it would appear that such a method of infection cannot be left out of account; as, however, this pig had been fed with tubercular material heated as above, and as tuberculosis was undoubtedly developed, this animal is included in our table, especially bearing in mind the possibility that a pig may draw some of the infective material with which it is being fed into the lungs, a mode of infection that has often been suspected, especially in kittens and in pigs, though in most of the other cases where this has occurred there has been evidence of primary infection at other points, so that the minor and secondary infection might be left out of account. It is evident from what has already been said concerning infection of the pharynx and of the lower part of the intestine in pigs and guinea-pigs that infection may occur at both points simultaneously.

Possible infection of pig through respiratory passages.

Feeding experiments with pigs also afford evidence of effects of heat in attenuating tubercular material.

It will be gathered, too, from the results obtained from these four pigs that there is a marked attenuation of the tubercle bacillus when it is subjected to continued heating at 70° C. The animal fed with milk heated for 7½ minutes, killed on the 85th day, was not so extensively tubercular as the control animal which died in 42 days. In the animal fed with milk heated for 15 minutes, the disease was not nearly so far advanced on the 91st day when the animal died, although, of course, it died so much earlier than the control animal fed with the same artificial tubercular milk, which was not killed until the 117th day, but in which the disease was of a much more advanced nature. This, however, does not bring out the extent of the attenuation nearly so markedly as in the previous experiment, though one undoubtedly expected to observe the results of some attenuating influence.

The pig fed with the material heated for 30 minutes and that died suffering from bacterial necrosis on the 43rd day, as we have already seen, did not show any tubercle, and it may be that this was too early a date to allow of the weakened tubercular material setting up tuberculosis, whilst the one fed with milk heated for 45 minutes and killed on the 115th day, although undoubtedly tubercular, was so slightly affected that the attenuation must have been very marked indeed. It is only necessary to compare the two post-mortem records of the control pigs with those given above to bring out very distinctly the fact that attenuation of the material is very marked.

One of the main points to notice in connexion with this series of experiments is, that pigs may apparently contract tuberculosis from material that has been heated to 70° C. for quite as long as similar material used in injection experiments will produce tuberculosis in guinea-pigs. In this instance, indeed, the time heated was slightly longer, as it was found that the guinea-pigs never became affected with tuberculosis from injection with artificial tubercular milk heated to 70° C. for a longer period than 30 minutes.

Control Injection Experiments.

Control experiments. Materials used.

164 In the injection experiments the following materials were proved by control experiments to be undoubtedly infective, in addition to those that had been proved to be tubercular in the feeding experiments. Several of the materials (Nos. 3, 8, and 9) proved to be infective in both feeding and injection experiments.

Material No. 1, which did not give tuberculosis in the feeding experiments, proved to be infective at the end of 33 days to one out of three guinea-pigs injected. The tubercular process, however, was not far advanced, and could scarcely have been the cause of the death of the animal.

Of three guinea-pigs injected with Material No. 3, two died from tuberculosis, one in 33 and the other in 40 days; the third animal remained unaffected.

Material No. 5 proved fatal to all three guinea-pigs into which it was injected; the animals succumbed to tuberculosis, one in 22 days and the other two in 25 days each.

Material No. 5A set up a fatal tuberculosis in the two guinea-pigs that were injected, both dying on the 19th day.

No. 6 material set up a tuberculosis in all three guinea-pigs, carrying them off, one in 26 days, one in 27 days, and the other in 39 days.

Material No. 9 caused the death of two guinea-pigs by tuberculosis, one in 18 days, and the other in 56 days; in the second case the disease was far advanced, but in the first, death appears to have been due to the suppurative changes that were set up.

Injection Experiments with Heated Material.

Cases in which positive results were obtained.

On the left-hand side of the table (Part XIII., Table CVII., p. 266, *et seq.*) the first animal come across that was affected with tuberculosis was one injected subcutaneously with material that had been heated to 70° C. for 2½ minutes; it is the only one of the group that was inoculated subcutaneously, and it is evident that the process resulting is of a somewhat chronic nature, as in all the nodules of tubercle the amount of new connective tissue is comparatively great, the lesion resembling the scar-tissue tubercle which has been described in several of the other animals fed or injected, in which the infective material, had been exposed to the action of heat for some time. The presence of this scar-tissue would seem to indicate that the tubercular material even when subjected to this moderate temperature, and for so short a time, had undergone a certain degree of attenuation. The same thing is observed in another guinea-pig injected with materials Nos. 1, 2, 3, 4, heated for the same time in a similar fashion; but even here it appears to be probable that several of the samples of material had been rendered innocuous, and that only one out of the group had retained a certain degree of virulence (probably the last which was given 13 days before the animal was killed) as a result of which an abscess had been formed, in which abscess tubercle bacilli were found along with other organisms. This animal was killed at the end of 157 days after the first injection, and with the exception of the tubercular abscess mentioned, which must be looked upon rather as a local necrotic change due to the action of the caustic irritant material present in the dead bacilli, than as a true tuberculosis, the other organs, although matted together by an inflammatory process, were unaffected. It is possible that, just as in a number of other cases, the inflammatory changes are due to the presence of the dead bacilli, and that those bacilli (seen under the microscope) were incapable of setting up tuberculosis at distant parts, owing to the fact that their vitality had been destroyed by the heat before they were injected; this, however, is merely hypothetical, and these experiments must be included in the table as cases of tuberculosis.

Local abcess formation.

Is this due to caustic action of dead bacilli?

We have still further evidence of the attenuation of the tubercular material in the appearances presented in the last series of animals injected with material that had been heated to 70° C. for 5 minutes, and then again in the first series injected with material heated to 70° C. for 10 minutes; in one animal of each set killed on the 84th day localised tuberculosis was found. In neither of these was it possible, however, to demonstrate, after a most careful search, the presence of the tubercle bacillus, but the histological characters of the growths so resembled those met with in other animals in which tubercle bacilli were found, that I have no hesitation in including these animals in the table, as having suffered from tuberculosis set up by an attenuated virus.

In the second set of guinea-pigs inoculated with artificial tubercular milk, heated for 10 minutes, we have again the peculiar localised condition occurring in animals that died at the end of 14 days after the first injection; here again the bacilli found in the fluid of the abdominal cavity may well have been dead bacilli that had been injected but not absorbed. As, however, the animals succumbed to a peritonitis, and as tubercle bacilli were demonstrated in the fluid found in the abdominal cavity, the presence of these conditions must be accepted tentatively as indicating the tubercular nature of the process.

The next animal in which tuberculosis is met with is one of the guinea-pigs, injected with materials Nos. 1, 2, 3, 4, and 5, heated to 70° C. for 15 minutes, the animal being killed 165 days after the first injection, or six days after receiving the fifth or last injection, which therefore could not have had anything to do with the condition that was met with. There was evidently well marked tuberculosis, which had spread from the peritoneal cavity; the spleen was enormously enlarged, and the mesenteric glands slightly enlarged and tubercular. This condition undoubtedly could not be the result of the action of dead bacilli, and this case must be looked upon as one in which the disease and the spread to other parts was exceedingly slow and very limited. It is evident that in this case the material had been considerably attenuated.

Mixed infectio

No case of tuberculosis is again met with out of a considerable number of injection experiments, until we come to the set of animals injected with artificial tubercular milk, heated for 30 minutes, the first and the last of which animals were both tubercular. It is evident that the first case is associated with some suppurative change which may possibly have decreased the resisting power of the tissues to which the tubercle bacilli had gained access. This factor of "mixed infection" appears to play a most important part in determining the nature of the lesions that were found in several of the animals examined in this series. In the last animal of the 30 minutes set, killed 115 days after receiving an injection of No. 9 material, there can be no doubt that we have a true tubercular lesion as usually understood, the right inguinal gland showing undoubted evidence of tuberculosis, whilst a small nodule in the liver is probably of a similar nature, although no tubercle bacilli could be found. It is evident, however, that the disease was of an exceedingly mild character, and that it ran a very prolonged course; it cannot, on this account, be left out of our calculations.

Heating 70° C. fo 45 minu sufficien render a tubercul material innocuo

From these injection experiments it would appear that tubercular material still remains capable of setting up tuberculosis, even when heated to 70° C. for 30 minutes; after this, however, the material becomes innocuous, even when injected intraperitoneally, for of four guinea-pigs so injected with material heated at 70° C. for 45 minutes, six injected with it after the heating had gone on for an hour, three injected after the heating had been carried on one hour and a half, and five injected with it after two hours' heating, not one developed the slightest trace of tuberculosis. It was not considered necessary to continue the experiments at this temperature further.

The following table gives the results obtained with guinea-pigs, whether positive or negative.

165 TABLE LVII.

Experiments on Guinea-pigs with Artificial Tubercular Milk, heated at 70° C. (158° F.)

Summary.

——	Feeding.	Injection.
Heated to 70° C.	Nil	Nil.
2½ minutes	Nil	**Tubercle.**
5 minutes	**Tubercle**	**Tubercle.**
7½ minutes	No experiments	No experiments.
10 minutes	Nil	**Tubercle.**
15 minutes	Nil	**Tubercle.**
20 minutes	Nil	Nil.
30 minutes	Nil	**Tubercle.**
45 minutes	Nil	Nil.
1 hour	Nil	Nil.
1½ hours	Nil	Nil.
2 hours	Nil	Nil.

As already mentioned, three **pigs**, fed with material heated at this temperature for 7½ minutes, 15 minutes, and 45 minutes, developed tuberculosis. One pig, fed with material heated for 30 minutes, escaped infection.

Importa of a singl positive result.

One or two of the control feeding experiments gave negative results, in this and in other series, when, however, two out of the three control animals became tubercular, the material must have been comparatively virulent, the necessity for accepting a single positive result out of a very large number of negative results in the heating experiments, can scarcely be too strongly insisted upon. Wherever one positive result was obtained from the use of material heated up to a certain point and for a certain time, the danger of infection from the material so treated must be accepted as being very great, and from a consideration of the whole of the experiments up to this point, one is led to the conclusion that the results obtained, especially when the percentage of positive results was small, should represent the minimum rather than the maximum danger attending the use of such heated material, and any practical deductions and regulations based thereon should rather go beyond than fall short of those indicated by the precautions that have been taken in carrying out these experiments. This caution necessarily applies not merely to the milk experiments, but in equal measure to those experiments carried on with the meat taken from tubercular cattle.

EXPERIMENTS WITH ARTIFICIAL TUBERCULAR MILK HEATED TO 75° C. (167° F.).

erials d in se ex- iments.

166 Material No. 1.—(For details, *see* Part XIII., Table CVIII., p. 270, *et seq.*) This material was composed of the juice and pulp of the glands of several tubercular guinea-pigs, added to 200 cc. sound milk. It was heated for two minutes over the Bunsen burner, when it had attained a temperature of 75° C., the heating was continued over an open water bath. This material was used for injections only.

Material No. 2 was given on the 14th day. This consisted of 300 cc. of the juice and pulp of the tubercular lung of Cow No. 25, mixed with 4,000 cc. sound milk. The heating of this material up to 75° C. took five minutes over the Bunsen burner; the heating was continued in the steriliser.

Material No. 3, given on the 34th day, consisted of the tubercular juice and pulp of liver, spleen, lungs, and glands of a pig and several guinea-pigs, heated over the Bunsen burner to 75° C.; heating continued in the steriliser.

Material No. 4, given on the 56th day, consisted of the juice and pulp of a tubercular human lung added to sound milk. It was heated in the steriliser.

Material No. 5, given on the 61st day, consisted of the juice and pulp of the tubercular udder of a cow to which sound milk was added. It took 10 minutes to heat up to 75° C. over the Bunsen burner. The heating process was continued over the water bath.

Material No. 6 was given on the 66th day. It consisted of the juice and pulp of a tubercular human lung added to sound milk. This was heated over the Bunsen burner to 75° C., and was then placed in the water bath.

Material No. 7, given on the 77th day, consisted of the juice and pulp of the tubercular lung and glands from Cow No. 25, added to sound milk. It was treated in the same manner as No 6.

Material No. 8, given on the 83rd day, consisted of the caseous material of the glands of Cow No. 25, added to a quantity of sound milk. It was treated as were Nos. 6 and 7.

Material No. 9, given on the 89th day, consisted of the juice and pulp of a tubercular human lung added to sound milk. It was then treated as were Nos. 6, 7, and 8.

Material No. 10. This artificial tubercular milk was used simply in one set of injections, viz., to test the action of a sample of the milk heated up to 75° C. over a Bunsen burner. It consisted of the juice and pulp of a tubercular lung of a cow received from the Metropolitan Cattle Market.

npera- e records ing ting.

Records were kept of the temperatures attained during the process of heating No. 1 and 5 materials in the water bath. In the case of No. 1 the milk was first heated to 75° C. over the Bunsen flame, a temperature which was reached in two minutes; so rapid, however, was the fall on removing the flame that by the time the milk could be transferred to the heated beakers and placed in the water bath the temperature had fallen to below 73° C. At the end of two minutes in the water bath its temperature still only registered 73° C., but the temperature then rose rapidly, and at 7½ minutes registered 75°·75 C. On the last beaker being removed from the water bath after the heating was finished the temperature fell from 76° C. to 62° C. in 2½ minutes, and in five minutes to 53° C. In this instance the quantity of milk being dealt with was small, as the material was only to be used for injection purposes.

No. 5 material, in which the heating process was also begun over the Bunsen burner, and was continued in the water bath, was larger in quantity, and the variations in temperature were therefore not nearly so great at any time, nor did they occur so rapidly. From 1 minute up to 15 minutes it never varied more than a degree (from 75° C. to 76° C.), and on the last beaker being removed from the water bath the temperature of the milk fell only 6° C. in the first three minutes, 5° C. more in the next three minutes, and 8° C. in the next six minutes.

The material, of which the heating was continued in the steriliser, was maintained at 75° C., or within half a degree of that temperature throughout the process.

167 TABLE LVIII.

Temperatures at which Materials Nos. 1 and 5 were maintained in the Water Bath and Steriliser respectively during this Series of Experiments.

Time in Water Bath.	Material No. 1.	Time in Steriliser.	Material No. 5.
	°C.		°C.
2 minutes -	73	**1** minute -	75
4 minutes -	74·5	**5** minutes -	75·3
7½ minutes -	75·75	**10** minutes -	75·75
11 minutes -	77	**15** minutes -	76
15 minutes -	75		
22½ minutes -	75·5		
30 minutes -	76		

When the last beaker was taken out of the water the temperature of the milk fell in 2½ minutes to 62° C., and in 5 minutes to 53° C.

When the last beaker was taken out of the water the temperature of the milk fell in 3 minutes to 70° C.; in 6 minutes to 65° C.; and in 12 minutes to 57° C.

Water bath used as steriliser.

The water bath was only used when the steriliser was occupied with the material for other experiments, as it was always felt that the exposure of the surface of the milk to the air was a slight obstacle to the maintainance of an equable temperature throughout. This, however, can scarcely have had much influence in retarding the process of attenuation of the tubercle bacilli, for, as will be seen from the above tables, the temperature (taken pretty frequently) was well maintained, and each time that the temperature was taken the material was stirred thoroughly, so that the surface layer was changed each time.

Control Feeding Experiments.

Control experiments.

168 Feeding control experiments were carried on with artificial tubercular milks Nos. 2, 4, 5, 6, 7, 9, and 10. As will be seen from the detailed Table No. CVIII., Part XIII., p. 270, *et seq.*, these materials were fairly active.

Two of the guinea-pigs fed with Material No. 2 were killed on the 119th day in an advanced stage of tuberculosis.

Of two guinea-pigs fed with Material No. 4, only one became affected, though when killed on the 129th day it gave evidence of an advanced affection; the intestines were ulcerated, and most of the other organs and glands were distinctly tubercular. The cat fed with the same material and killed on the 77th day was found to have two small tubercular patches in the cortex of one of the mesenteric glands, and in these small patches numerous tubercle bacilli could be demonstrated.

Evidence of mixed infection.

Material No. 6 set up tuberculosis in a single guinea-pig fed with it, but the animal died from some intercurrent disease, as when it succumbed on the 24th day after the first feeding there was only very slight evidence of tubercle; as however, there was ulceration of the intestine, and as the other two animals of this set appear to have died in eight days from some septic condition, it is possible that here we had to do with a mixed infection which was indeed probably the cause of the death of all these animals.

No. 7 material was somewhat virulent, as of three guinea-pigs fed with it all became tubercular, one being affected with well-marked tubercular disease when it died on the 33rd day, the other two also showing marked evidence of a tubercular process on being killed on the 56th day.

No. 9 material was not so virulent, as only two out of three animals fed with it developed tuberculosis, but in them, when killed on the 104th day, a somewhat extensive affection was found.

A pig fed with four of the above Materials, Nos. 5, 6, 7, and 9 developed well-marked tuberculosis, primarily, apparently, from the pharynx or tonsils, but also in connexion with the lower reaches of the alimentary tract, as will be seen from an examination of the lesions recorded in Table CVIII., Part XIII., p. 271.

No. 10 material was undoubtedly also virulent, as of three guinea-pigs fed with it two succumbed to tuberculosis on the 35th and 37th days, and the third on the 63rd day.

169 TABLE LIX.

Experiments with Artificial Tubercular Milk Heated at 75° C. (167° F.)

Time heated.	Feeding Experiments. Number of Animals used in Experiments.	Result with Animals that lived over 28 Days. No. of Animals.	Result.	Injection Experiments. Number of Animals used in Experiments.	Result with Animals that lived over 21 Days. No. of Animals.	Result.
Heated to 75°	3 guinea-pigs	3	Nil	6 guinea-pigs	6	**3 tubercular.** 3 nil.
	2 kittens	2	Nil			
5 minutes	1 kitten	1	**Tubercular**	—	—	—
	1 pig	1	**Tubercular**			
7½ minutes	3 guinea-pigs	3	**1 tubercular** 2 nil	3 guinea-pigs	3	**2 tubercular.** 1 nil.
10 minutes	1 kitten	1	**1 tubercular**	—	—	—
	1 pig	1	**1 tubercular**			
15 minutes	3 guinea-pigs	3	Nil	3 guinea-pigs	3	**1 tubercular.** 2 nil.
	1 cat		**Tubercular**			
	1 pig		**Tubercular**			
22½ minutes	—	—	—	3 do.	3	**1 tubercular.** 2 nil.
30 minutes	—	—	—	3 do.	3	Nil.
45 minutes	—	—	—	3 do.	3	Nil.

Control Feeding Experiments, **18** guinea-pigs, **13 tubercular,** 2 nil, 3 too early to show tubercle. **1** cat, **tubercular, 1** pig, **tubercular.**

Control Injection Experiments, **11** guinea-pigs, **9 tubercular,** 2 too early to show tubercle.

Feeding Experiments with Heated Material.

Only one guinea-pig succumbed.

170 Coming now to the feeding experiments with the heated material, and dealing first with the experiments on guinea-pigs, it is found that the only animal affected was one that was fed with materials Nos. 2, 5, 6, 7, and 9, maintained at a temperature of 75° C. for 7½ minutes. It was one of a set of three fed with the same material and died 41 days after it had received the first feeding; the tubercle as seen in this animal was undoubtedly in a very early stage of development, and the tuberculosis at such a stage could not have been the cause of the death of the animal.

Taking the feeding experiments carried on with guinea-pigs alone, it would seem to be an exceedingly easy matter to sterilise artificial tubercular milk by heating it to 75° C. When, however, we come to examine the results obtained from the feeding experiments carried on with other animals it soon becomes evident that what has been observed in the earlier series of experiments at lower temperatures here receives ample corroboration. The pig fed with artificial tubercular milk, Nos. 5, 6, 7, and 9, heated to 75° C. for 5 minutes contracted tuberculosis; when the animal was killed on the 117th day there was marked evidence of invasion from the pharynx or tonsil, from which point the disease appears to have spread very rapidly from the glands in the neck, down into the chest. There was also tubercular affection of the glands of the abdomen.

Pigs much more regularly affected.

Kittens affected.

The kitten fed with artificial tubercular milks Nos. 7, 8, and 9, heated for the same time, died on the 59th day. Although no tubercle bacilli could be found, the condition in this animal resembled very closely that met with in the cat fed with No. 9 material heated to 75° C. for 15 minutes, in the lesions of which tubercle bacilli were easily demonstrated.

Artificial tubercular milks Nos. 5, 6, 7, and 9, heated to the same temperature for 10 minutes, proved fatal to one pig in 92 days, the invasion as in the other cases, evidently being from the pharynx or tonsil. In a cat fed with milk No. 9, material heated to the same temperature and for the same time, there was ulceration of the vermiform appendix, very similar to that described in the above kitten, but here tubercle bacilli were readily demonstrated.

Tubercle bacilli found in lesion in cat.

Artificial tubercular milk heated to 75° C. for 15 minutes had not the slightest effect on guinea-pigs fed with it, but a pig fed with Nos. 5, 6, 7, and 9, so heated, developed well-marked tuberculosis, the disease again advancing from the pharynx or tonsil, whilst a cat fed with No. 9 material developed the same ulceration in the intestine associated with the presence of tubercle bacilli in the ulcerated tissue at the entrance of the vermiform appendix, as above described. In the case of the pig fed with the artificial tubercular milk heated for 15 minutes the disease is not nearly so far advanced as in those in which the artificial tubercular milk had not been subjected to so high a temperature, or to so prolonged a period of heating, and we have evidently an attenuation of the virus which has interfered with the development of the tubercular process as a result of its ingestion.

Eviden attenua

Irregula of result

Here, again, the results obtained are somewhat irregular, but it is evident on consideration of the table that we are just at the borderland of the point of sterilisation as regards temperature and time of heating, as in this series of experiments a very large number of the animals escaped the disease, even when certain of the specimens of artificial tubercular milk were simply heated to 75° C., but in other cases (in only one from amongst the guinea-pigs, but in all the pigs and in most of the cats) the development of the disease went on up to the extreme limit of time of heating applied for feeding experiments. This time, however, was below that which was necessary to render the artificial tubercular milk innocuous when *injected* into guinea-pigs. These experiments may, therefore, be taken as accurately representing the virulence of the material used, for in these feeding and injection experiments the fact has been brought out in an exceedingly satisfactory manner that so long as tubercular material remains infective by *injection* into guinea-pigs so long or nearly so long must it be regarded as capable of setting up the disease in pigs by *feeding*.

Injectio experim in guine pigs important in relatio to point sterilisat for feedi pigs.

In these feeding experiments exposure to a temperature of 75° C. for a longer period than 7½ minutes is perfectly capable of rendering this artificial tuberculous material innocuous as far as the affection through the alimentary canal in guinea-pigs is concerned, but heating for a quarter of an hour is not sufficient to render it innocuous to pigs, kittens, and even to cats, although in many of the other experiments the cats fed with materials heated at lower temperatures escaped even when apparently more virulent material was used. What the reason of this is it is at present impossible to say. Similar material, as we shall see, remained capable of infecting guinea-pigs by injection, even when it had been heated for 22½ minutes, but never beyond this point, and it may therefore safely be assumed, arguing from the other sets of experiments, that this same material similarly treated would be innocuous to both cats and guinea-pigs, when introduced into the alimentary tract.

Control Injection Experiments.

trol ex- ments.

171 The control injection experiments indicate that the materials used were of a comparatively virulent type.

Two guinea-pigs injected with No. 1 material succumbed, one on the 58th day and the other on the 80th day after injection.

Two guinea-pigs injected with Material No. 3 died from tuberculosis on the 19th day after injection.

Of two guinea-pigs injected with Material No. 7 one succumbed to the disease on the 18th day, but the other remained alive until the 56th day, when it was killed; the disease was well advanced and was somewhat widely distributed.

Three guinea-pigs injected with No. 10 material developed tuberculosis, one dying on the 16th day suffering from very early tuberculosis, the cause of death appearing rather to be some septic condition (as a small abscess was formed) than the tubercular process itself. The other two animals of this set, killed on the 44th day, were in an advanced stage of tuberculosis.

It will be seen on comparing the two sets of control experiments with Nos. 7 and 10, the only two sets used both for feeding and injection control purposes, that both were of a somewhat virulent nature, setting up tuberculosis in every case in which they were used, and carrying off the animals, both those injected and those fed, in a comparatively short time.

Injection Experiments with Heated Material.

172 Of six guinea-pigs injected with material simply heated to 75° C., only three became tubercular, and these were all injected with material No. 10, one dying on the 26th day, the other two on the 45th day; it can scarcely be said that this heating had brought about any prolongation of the course of the disease. The three other animals injected with Nos. 3 and 4 all escaped, so that the heating in this latter case was quite sufficient to render these samples of artificial tubercular milk innocuous. Curiously enough, however, these same materials, Nos. 3 and 4, along with No. 1, after being heated to 75° C. for 7½ minutes, caused the death of a guinea-pig, the animal dying in 80 days, whilst Nos. 3 and 4 alone, also heated for 7½ minutes, set up tuberculosis in an animal which however lived until it was killed on the 98th day after injection.

ence of uation,

Although the animals are distinctly affected with tuberculosis, the course of the disease has been very considerably prolonged, and the character of the lesions rendered much more chronic, these lesions being characterised by a somewhat greater development of fibrous tissue than is usually met with in the tubercular lesions of the guinea-pig.

The same thing may be noticed in the case of a guinea-pig that was killed 132 days after it had been injected with artificial tubercular milks Nos. 1, 3, and 4 heated at 75° C. for 15 minutes. The disease in this case is very extensive, but curiously enough the number of tubercle bacilli found on microscopic examination is very small. Here, too, induration is a marked feature of the lesions, whilst where there is actual breaking down of the tissues the process is always accompanied by the presence of micro-organisms other than the tubercle bacillus.

mixed tion.

The same artificial tubercular milks Nos. 1, 3, and 4, when heated to 75° C. for 22½ minutes again gave tuberculosis in one out of three animals injected. This animal killed on the 132nd day afforded evidence of an exceedingly chronic, though at the same time widespread tubercular process; any softened patches found were also characterised by the presence of numerous short rods and cocci stained blue, although in addition degenerated and imperfectly stained, tubercle bacilli could be made out sparsely scattered throughout the cover glass preparations. Using artificial tuberculous milk, heated to this same temperature for periods beyond this, 30 and 45 minutes, no positive results were obtained.

tive ctivity aterial

The same ratio between the infectivity by feeding and by injection that has already been noted in several other tables obtains here, *i.e.*, the time of exposure to this temperature (75° C.) necessary to render tubercular material innocuous to guinea-pigs for feeding is only about one-third of that necessary to render it harmless for injections, whilst it is also brought out that so long as this heated milk remains capable of setting up infection by injection into guinea-pigs so long or nearly so long does it remain capable of setting up infection through the upper part of the alimentary canal (tonsils and pharynx) in the pig. This has already been strongly insisted upon in other series, but it is brought out equally well in this set of experiments.

in feeding and injection experiments in different animals.

Parts affected in cats fed with artificial tubercular milk.

The results of feeding experiments with cats are interesting only in so far as they differ somewhat from many of those carried on in other series of experiments at lower temperatures. It is evident, however, that in the cat, under the conditions used in our experiments, the part of the intestine near the vermiform appendix is that most usually affected, as not only was the ulceration in these cases and in others usually found in this position, but where any glands were affected in the cat they were almost invariably those connected with this point of the intestine.

The following table gives at a glance the points, as regards time of exposure to a temperature of 75° C., at which positive result, were obtained in the feeding and injection experiments, carried on with guinea-pigs. This series of experiments may be compared with the similar series carried on with materials heated at other temperatures.

173 TABLE LX.

Experiments or Guinea Pigs with Artificial Tubercular Milk, heated at 75° C. (167° F.)

Summary.

Fed with Milk heated to 75° C. for	Feeding.	Injection.
Heated to 75°	Nil - -	**Tubercle.**
7½ minutes -	**Tubercle** -	**Tubercle.**
15 minutes -	Nil - -	**Tuberle.**
22½ minutes -	No experiments -	**Tubercle.**
30 minutes -	No experiments -	Nil.
45 minutes -	No experiments -	Nil.

Comparison of 70° C. and 75° C. sets of experiments.

On comparing the two sets of feeding and injection experiments, carried on at 70° C. and 75° C., the general results, as will be seen from the subjoined table, agree in a most remarkable manner, the only discrepancy being a comparatively small one, but one to which reference must be made, as it shows that a certain margin must, especially in all cases of feeding, be allowed for individual constitutions of animals, or some other modifying factor. It is only by taking the average of a large number of experiments that any reliable or accurate results can be obtained, and when only one or two positive results are obtained out of a large number of animals, it is evident that these positive results may be due partly to the large dose of infective material given, partly to the constitution of the individual animal, partly to the state of the secretions at the time at which the material is given, and partly to the state of nutrition of the animal. When, therefore, it is found that positive results are obtained in feeding experiments made with artificial tubercular milk that has been heated to 75° C. for 7½ minutes, on the one hand, whilst no positive results are obtained with artificial tubercular milk, after it has been heated at 70° C., for a longer time than five minutes, the above factors must naturally be borne in mind; the margin of error of experiment being necessarily greater in the case of the feeding experiments than in the case of injection experiments, and when we come to consider the injection experiments, it will be noted that the results again come out as one would expect from a consideration of the results recorded in the previous tables, exposure to a temperature of 70° C. for 30 minutes, being the limit in the one case, whilst in the other, heating to 75° C. for 22½ minutes, constitutes the limit.

Explanations offered of slight differences obtained.

174 TABLE LXI.

Table showing Results obtained with Artificial Tubercular Milk, heated at 70° and 75° C.

Time in Steriliser.	Feeding.		Injection.	
	70° C.	75° C.	70° C.	75° C.
Heated to	Nil	Nil.	Nil	**Tubercle.**
2½ minutes	Nil	No experiments.	**Tubercle**	No experiments.
5 minutes	**Tubercle**	No experiments.	**Tubercle**	No experiments.
7½ minutes	Nil	**Tubercle.**	No experiments	**Tubercle.**
10 minutes	Nil	No experiments.	**Tubercle**	No experiments.
15 minutes	Nil	Nil.	No experiments	**Tubercle.**
20 minutes	Nil	No experiments.	Nil	No experiments.
22½ minutes	No experiments	No experiments.	No experiments	**Tubercle.**
30 minutes	Nil	No experiments.	**Tubercle**	Nil.
45 minutes	Nil	No experiments.	Nil.	Nil.
1 hour	Nil	No experiments.	Nil	No experiments.
1½ hours	Nil	No experiments.	Nil	No experiments.
2 hours	Nil	No experiments.	Nil	No experiments.

EXPERIMENTS WITH ARTIFICIAL TUBERCULAR MILK, HEATED TO 80° C. (176° F.).

Materials used.

175 Material No. 1 (for details, *see* Part XIII., Table CIX., p. 274, *et seq.*), consisted of the juice and pulp of the tubercular glands of several guinea-pigs added to sound milk. In two minutes, over a Bunsen burner, the milk had attained a temperature of 80° C.; it was then placed in the water bath and kept at the same temperature.

Material No. 2, given 14 days later, consisted of 300 cc. of the tubercular milk from Cow No. 25, to which was added the juice and pulp of the tubercular lung of a cow received from the Metropolitan Cattle Market. To this mixture 4,000 cc. of sound milk was added. Only a portion of this material was required for this set of experiments, and the remainder was used in the 75° C. series and other series. The heating up process lasted for five minutes only. When the material had reached the necessary temperature of 80° C., it was transferred to the "steriliser."

Material No. 3 was given on the 34th day; it consisted of the juice and pulp of the tubercular lung, liver, and spleen of a pig, and the tubercular organs of several guinea-pigs, added to a quantity of sound milk.

Material No. 4 was given on the 56th day; it was made of the juice and pulp obtained from a tubercular human lung, added to a quantity of normal milk.

Material No. 5, given on the 60th day, consisted of the juice and pulp obtained from the tubercular udder of a cow, mixed with sound milk. This material took five minutes to reach 80° C, over the Bunsen burner; it was then placed in the steriliser.

Material No. 6, given on the 65th day, consisted of the juice and pulp obtained from a tubercular human lung, to which was added a quantity of sound milk. The process of heating up to 80° C. lasted 5½ minutes.

Material No. 7, given on the 77th day, consisted of the juice and pulp made from the tubercular lung and glands of Cow No. 25, to which normal milk was added.

Material No. 8 was given on the 87th day; it was composed of the juice and pulp expressed from a tubercular human lung, mixed with normal milk. This took four minutes to heat to 80° C. over the Bunsen flame.

Material No. 9, given on the 143rd day, consisted of the juice and pulp obtained from the lung of a tubercular cow sent from the Metropolitan Cattle Market, to which a quantity of normal milk was added. The heating up to 80° C., in this instance, took only three minutes.

Heating of the Artificial Tubercular Milk.

Tempe tures a tained during heating process

176 The following examples of the temperatures attained by the artificial tubercular milks in this series of experiments will give an idea of the comparative regularity of the temperature maintained throughout. As the time that the milk was heated to 80° C. in no instance required to be very prolonged, it was a comparatively easy matter, by regulating the flame of the Bunsen burner by hand, to maintain a temperature sufficiently accurate for purposes of experiment. As will be seen in the case of Material No. 1, there was a slight fall for a minute or two after the milk had been transferred to the beakers, but this had been rectified at about the end of three minutes. Again, at 15 minutes there was a rise of a single degree beyond the point required. In the case of Material No. 5 the temperature never varied more than 0·75° C. from that required, and it never fell below 80° C. No. 2 material was the only one of this series that was heated in the steriliser after the temperature had once been brought to the necessary height; all the others were heated in the water bath.

177 TABLE LXII.

Temperature at which Materials Nos. 1 and 5 were maintained in the Water Bath during this Series of Experiments.

Time in Water Bath.	Material No. 1.	Time in Water Bath.	Material No. 5.
	° C.		° C.
1 minute	78·5	**1** minute	80
2½ minutes	79·5	**2** minutes	80·5
5 minutes	80	**3** minutes	80
10 minutes	80	**4** minutes	80
15 minutes	81	**5** minutes	80·5
20 minutes	80	**7½** minutes	80·75
		9 minutes	80
		10 minutes	80

The temperature of the milk in the last beaker taken from the water bath fell in—

1 minute to 73° C.
2 minutes to 67
3½ minutes to 62
4 minutes to 60

The temperature of the milk in the last beaker taken out of water bath fell in—

2 minutes to 75° C.
4 minutes to 70·5
5 minutes to 69
8 minutes to 64

178 TABLE LXIII.

Experiments with Artificial Tubercular Milk heated at 80° C. (176° F.)

Feeding Experiments. **Injection Experiments.**

Time heated.	Number of Animals used in Experiments.	Result with Animals that lived over 28 Days.		Number of Animals used in Experiments.	Result with Animals that lived over 21 Days.	
		Number of Animals.	Result.		Number of Animals.	Result.
Heated to 80° C.	3 guinea-pigs -	3	Nil.	9 guinea-pigs -	7	1.
	1 cat - -	1	Nil.			
	1 kitten - -	—	Too early to show tuberculosis.			
5 minutes -	4 guinea pigs -	4	Nil.	3 do. -	3	Nil.
	1 cat - -	1	Nil.			
	1 pig - -	1	**Tubercular.**			
10 minutes -	4 guinea-pigs -	4	Nil.	3 do. -	3	Nil.
	1 pig - -	1	**Tubercular.**			
15 minutes -	—	—	—	3 do. -	3	Nil.
20 minutes -	—	—	—	3 do. -	3	Nil.

Control Feeding experiments, **9** guinea-pigs, **4 tubercular,** 1 nil, 4 too early to show tubercle. **1** cat, **tubercular.** 1 pig, **tubercular.**

Control Injection experiments, **8** guinea-pigs, **7 tubercular,** 1 too early to show tubercle.

Control Feeding Experiments.

ntrol ex-
riments.

It is evident from the number of tubercular animals that appear amongst the control experiments that there can have been be no lack of virulence in the artificial tubercular milk here used.

Feeding Experiments with Heated Material.

179 In this series, as far as guinea-pigs are concerned, heating to a temperature of 80° C. is sufficient to render artificial tubercular milk innocuous. Pigs, however, contracted the disease when fed with the same material heated to 80° C. for 5 and 10 minutes respectively. In the first case, although the course of the disease was evidently somewhat modified, the animal was markedly tubercular, the disease apparently commencing in the glands around the pharynx and tonsils. The disease was somewhat wide-spread and tubercle bacilli could be readily demonstrated. In the case of the second pig the disease was not nearly no far advanced, but there can be no doubt that it had contracted tuberculosis, which also had extended from the region of the pharynx.

Injection Experiments with Heated Material.

All the injection experiments made with milk simply heated to 80° C. and with milk maintained at that temperature for from 5 to 20 minutes, gave absolutely negative results. We have, apparently, therefore, an example of material remaining capable of setting up infection through the tonsils of a pig long after it has been rendered innocuous to the tissues when introduced by injection into the peritoneal cavity of guinea-pigs. It should be noted, however, that the artificial tubercular milk used for feeding these pigs was not the same as that used for the feeding and injection of guinea-pigs. Here too, however, there is the same evidence of attenuation, on comparing the condition of the disease found in control pigs with those found in the pigs fed with the artificial tubercular milk.

The only legitimate deduction to be drawn from this whole series of experiments is, especially when taken in conjunction with the feeding experiments, that healthy individuals and animals of certain species may resist the action of attenuated tubercular material even when other species of animals under certain conditions are readily infected by the same material.

From what can be seen of the manner of infection in the pig and seeing how closely it corresponds with what takes place in debilitated or unhealthy children where the affection of the glands of the neck is of such common occurrence, it is evident that the process of heating must be carried on much further than is usually advised, in order that any tubercular material may be rendered innocuous to these individuals and species.

The following table shows at a glance the negative character of the results obtained by feeding and injecting guinea-pigs:—

180 TABLE LXIV.

Experiments on Guinea Pigs with Artificial Tubercular Milk heated at 80° C. (176° F.)

Summary.

——	Feeding.	Injection.
Heated to 80° C.	Nil - -	Nil.
5 minutes - -	Nil - -	Nil.
10 minutes - -	Nil - -	Nil.
15 minutes - -	No experiments	Nil.
20 minutes - -	No experiments	Nil.

EXPERIMENTS WITH ARTIFICIAL TUBERCULAR MILK HEATED TO 85° C. (185° F.)

Materials used for experiments.

Material No. 1. (For details, *see* Table CX., Part XIII., p. 277, *et seq.*) This material consisted of the juice and pulp of the tubercular glands of a guinea-pig, added to 200 cc. of sound milk. The material placed over a Bunsen burner took 1 minute to reach 60° C., 1½ minutes to reach 70° C., and 2½ minutes to reach 85° C. When the milk had attained this latter temperature it was placed in the steriliser.

Material No. 2, given 28 days later, consisted of the juice and pulp of the liver, lungs, spleen, and glands of a pig and several guinea-pigs.

Material No. 3, given 34 days later, consisted of the juice and pulp of a tubercular human lung added to a quantity of sound milk. In this, in 6 minutes, over the Bunsen burner, the thermometer registered 85° C.

Material No. 4 consisted of the juice and pulp of a tubercular lung received from the Metropolitan Cattle Market. It was used, simply heated to 85° C., for one set of injections only, viz., three guinea-pigs. The temperature of the milk was brought to 85° C. in 2½ minutes.

Material No. 5 was made up of tubercular milk from Cow No. 25 plus the juice and pulp of a tubercular cow's lung mixed with sound milk. This material, kept at 85° C. for 5 and 7½ minutes respectively, was used for feedings only. It was heated over the Bunsen burner and then placed in the water bath for the remainder of the time during which it was maintained at 85° C.

The only record kept of the temperature maintained during the time that the artificial tubercular milk was being heated at 85° C. is the following: The heating was carried on over the water bath, but it will be seen that the temperature was fairly well maintained throughout the whole experiment, the temperature only falling half a degree between 5 and 7½ minutes, and being again normal at 10 minutes. The rate of cooling also was evidently fairly regular.

181 TABLE LXV.

Temperature at which Material was maintained in the Water Bath during the Series of Experiments at 85° C.

Time in Steriliser.	Temperature.
	° C.
5 minutes -	85
7½ minutes	84·5
10 minutes -	85

The temperature of the milk in the last beaker taken out of the water bath, fell in 1 minute to 80° C. and in 2½ minutes to 70° C.

Control Feeding Experiments.

ontrol ex- eriments.

Here again there can be no doubt that the artificial tubercular milk used was capable of setting up well-marked tuberculosis (*see* Table CX., Part XIII., p. 277.)

Feeding Experiments with Heated Materials.

Results c experime s with hea milk neg tive.

The feeding experiments with the heated material were in every case negative. Only guinea-pigs were used in this series of experiments. (*See* Table CX., Part XIII., p. 277.)

Control Injection Experiments.

Control c periment

Here again the control experiments carried on with the artificial tubercular milk used for injection purposes gave evidence that this milk was undoubtedly highly virulent.

Injection Experiments with Heated Material.

Heating concentrated artificial tubercul milk to 85° C. not sufficient to render innocuou

When we come to the injection experiments with the heated material, it is found that one set of guinea-pigs injected with No. 4 material heated to 85° C. (cooled down at once and then injected), produced tuberculosis in all of the three guinea-pigs to which it was administered; one died on the 44th day after injection, a second on the 52nd day, and the third was killed on the 62nd day; all were suffering from well-marked tuberculosis. The milk maintained at this temperature for any longer period invariably failed to produce tuberculosis when injected into the peritoneal cavity, not a single animal out of 14 so injected succumbing to the disease.

182 TABLE LXVI.

Experiments with Artificial Tubercular Milk heated to 85° C. (185° F.).

Time heated.	Feeding Experiments.			Injection Experiments.		
	No. of Animals used in Experiments.	Result with Animals that lived over 28 Days.		No. of Animals used in Experiments.	Result with Animals that lived over 21 Days.	
		No. of Animals.	Result.		No. of Animals.	Result.
Heated to 85° C.	3 guinea-pigs -	3	Nil.	6 guinea-pigs -	4	**3 tubercular.** 1 Nil.
2½ minutes -	3 Do. -	2	Nil.	3 do. -	1	Nil.
5 minutes -	3 Do. -	3	Nil.	3 do. -	2	Nil.
7½ minutes -	3 Do. -	3	Nil.	4 do. -	3	Nil.
10 minutes -	—	—	—	4 do. -	4	Nil.

Control Feeding Experiments. 6 guinea-pigs. **3 tubercular.** 3 too early to show tubercle.

Control Injection Experiments. 8 guinea-pigs. **7 tubercular.** 1 too early to show tubercle.

pparently iomalous sult.

This somewhat anomalous result, *i.e.*, obtaining positive results with artificial tubercular material heated to 85° C., when only negative results were obtained with the same kind of material heated to 80° C., can only be accounted for in two ways, and it is possible that both factors may have been involved in the production of these different results. The material may have been more virulent in one case than in the other, though on reference to the detailed Table CX., in Part XIII., p. 277, *et seq.*, it will be found that this factor is eliminated as Material No. 4, used in the 85° C. series of experiments is the same material as No. 9 used in the 80° C. series in which three guinea-pigs were injected, in this case with negative results, although the control experiments gave positive results. The other factor is, that the process of sterilisation by simply heating up was not quite so accurately performed in the one case as in the other; and as will be found on reference to the descriptions of the different artificial tubercular materials, the time taken in some cases to attain a given temperature was much less than in others, this time varying with the size of the flame, the quantity of material heated, and the form and size of the flask employed. It will be seen, indeed, that the time occupied to heat the artificial tubercular milk to 90° C. was only 2½ minutes, whilst in other cases heating for 8 or 10 minutes was only sufficient to raise probably a larger quantity of such milk to a temperature of 80°, 85°, or 90° C. The results, not the same in all cases, must consequently be accepted as being due to slightly varying conditions, such as those above-mentioned.

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oncentra- on of virus.

ime ex- osed to eat varies i different xperi- ents.

The under-noted table gives the result (positive or negative) obtained with guinea-pigs.

183 TABLE LXVII.

Experiments on Guinea Pigs with Artificial Tubercular Milk heated at 85° C. (185° F.).

Summary.

Time in Steriliser.	Feeding.	Injection.
Heated to 85° C.	Nil - -	**Tubercle.**
2½ minutes - -	Nil - -	Nil.
5 minutes - -	Nil - -	Nil.
7½ minutes - -	Nil - -	Nil.
10 minutes -	No experiments	Nil.

EXPERIMENTS WITH ARTIFICIAL TUBERCULAR MILK HEATED TO 90° C. (194° F.).

Materials used in experiments.

Material No. 1 consisted of the juice and pulp of the tubercular glands of guinea-pigs, added to sound milk. This material was used for injection experiments only. It was poured into a flask, care being taken to prevent its coming in contact with the sides. A thermometer was then fitted into a cork in the neck of the flask, so that the bulb only was immersed in the milk; the flask was then heated over a Bunsen burner. The temperatures registered are given below.

Material No. 2 consisted of tubercular milk from Cow No. 25, to which was added the tubercular lung (of cow) received from the Metropolitan Cattle Market, and a quantity of sound milk. This material was used for feeding experiments only, and the temperature of 90° C. was reached after eight minutes' exposure to the action of the flame of a Bunsen burner.

Material No. 3 consisted of tubercular milk from Cow No. 25, added to sound milk:—350 cc. of the former to 150 cc. of the latter. This material was used as a second feeding, and took four minutes to reach a temperature of 80° C. and 10 minutes to reach 90° C.

Material No. 4 consisted of the tubercular juice and pulp of the spleen, liver, lung, and glands of a pig, and the organs of a guinea-pig, to which sound milk was added. This material formed a third feeding for the same set of animals as were fed with the foregoing.

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ating this
terial.

The whole process of heating in this set of experiments was carried on in a flask which was protected from the direct action of the Bunsen flame by a piece of wire gauze only, the whole of the experiments being carried on in the same manner as described for Material No. 1.

The time taken for the temperature to rise and fall is given in the following table, and it may be taken as accurately representing the rise and fall in the other materials used in this set of experiments.

184 TABLE LXVIII.

Temperature at which Material was maintained in the Water Bath during the Series of Experiments, 90° C.

Time heated.	Temperature.
	° C.
1½ minutes - -	50
2½ minutes - -	66
3½ minutes - -	80
4½ minutes - -	90

and it cooled down in—

Time.	Temperature.
	° C.
1 minute - -	to 85
2 minutes - -	83
3 minutes -	81·5
4 minutes - -	79·5
7 minutes - -	75

Control Feeding Experiments.

Control ex-
periments.

Material No. 2 used in the feeding experiments was evidently fairly virulent, though one of the animals died too early to show tuberculosis; the other two were killed 119 days after the first feeding, when they were found to be in an advanced stage of tuberculosis, the intestines being extensively ulcerated, and a glandular affection fairly well marked.

Feeding Experiments with Heated Material.

Feeding
gave no
results.

Of three guinea-pigs fed with this same material heated to 90° C., and afterwards with Materials Nos. 3 and 4 treated in the same fashion, not one developed tuberculosis.

It was still, however, necessary to determine whether this simple heating to 90° C. was sufficient to destroy, completely, the virulence of tubercular material, and for this purpose some of the most virulent material that was used in any of the experiments was utilised for injection purposes.

185 TABLE LXIX.

Experiments with Milk to which obviously Tubercular Material had been added, and heated to 90° C. (194° F.).

Time heated.	Feeding Experiments.			Injection Experiments.		
	Number of Animals used in Experiment.	Result with Animals that lived over 28 Days.		Number of Animals used in Experiment.	Result with Animals that lived over 21 Days.	
		Number of Animals.	Result.		Number of Animals.	Result.
Heated to 90° C.	3 guinea-pigs - -	3	Nil.	3 guinea-pigs -	3	**3 tubercular.**

Control Feeding Experiments. **3 guinea-pigs. 2 tubercular.** 1 died too early to show tubercle.

Control Injection Experiments. **5 guinea-pigs. 5 tubercular.**

Control Injection Experiments.

ntrol ex-
iments.

It will be seen that of three guinea-pigs injected with Material No. 3, three died under 30 days, viz., in 22, 25, and 28 days respectively, and in these animals numerous tubercle bacilli were found in the tubercular lesions developed; the lesions in this respect differing somewhat from most of those found in animals of the other series of experiments that were carried on. The other material, No. 1, was not quite so virulent; of two guinea-pigs injected with it, one succumbed in 58 days and one in 80 days; as will be noticed, however, they received only one-tenth the quantity received by the other three animals.

Injection Experiments with Heated Material.

186 In the experiments with the artificial tubercular milk heated to 90° C., all the animals became affected with tuberculosis, although in each case there was evidence of marked attenuation of the virus; 5 cc. (that is a dose ten times as large as was received by the control animals of this series) of Material No. 1 injected into each of two guinea-pigs set up a somewhat chronic form of tubercle in one case, but in the other, although the lesions were of a somewhat fibroid character, the disease carried the animal off in 35 days.

With Materials Nos. 1 and 3, in doses of 0·5 cc. at each injection, there is again evidence of attenuation of the virus, as the only animal injected died at the end of 156 days. On being killed on that date only four or five tubercular nodules were found in the body, one in the spleen, three "cicatricial" patches—evidently tubercular—in the liver, and a single bluish grey tubercular point with a light yellow or greyish centre in the lung.

Simple
heating to
90° C. not
sufficient to
render con-
centrated
tubercular
material
innocuous
to guinea
pigs by
injection,
and to pigs
by inges-
tion.

In view of what has been observed in connexion with the feeding experiments with pigs at other temperatures, and comparing the results obtained with the injection experiments on guinea-pigs at 90° C., it is evident that bringing the temperature even up to this point is not sufficient to render exceedingly virulent tubercular material in the form in which it is met with in the above experiments (which were made to resemble as far as possible experiments carried on with milk taken from cows with tubercular udders) innocuous to animals. When, therefore, it remained capable of infecting guinea-pigs even by injection, it must be looked upon as still capable of setting up tubercular infection in children and more especially in children suffering from any lesion, functional or organic, of the alimentary tract, first of all in the region of the pharynx and tonsils, and secondly in the lower reaches of the

Conditions
predisposing
to tuber-
cular infec-
tion in
children.

Two factors to be considered, strength and number of tubercle bacilli and resisting or reacting powers of the tissues.

small intestine, the cæcum, and the upper part of the large intestine. Even when there is no actual lesion in any of these positions but only temporary functional derangement, it evidently happens that some of the weakened bacilli may be carried by leucocytes from the intestine into the lymphatics and lymphatic glands associated with it, and may thus set up changes in these glands. In some cases the bacilli appear to be killed off in the glands, and although some caseation may in these cases be set up in the gland, the caseous mass is afterwards surrounded by a cellular capsule, which becomes converted into fibrous tissue, and may ultimately, along with the caseous material, become partially absorbed; the lesion in such case is fairly distinctly localised, and unless injured or irritated may give rise to no further damage. In other cases the bacilli having once effected a definite footing appear to have the power of regaining some of their original virulence and of setting up a more generalised tuberculosis which may ultimately prove fatal. Only on some such hypothesis as this is it possible to explain the different sets of results obtained in experiments with tubercular material heated at various temperatures, and to bring them into line with clinical observation.

General Results and Conclusions.

Conditions of experiments vary. Corresponding variation in results obtained.

187 The heating experiments carried on with the view of rendering a disease germ, such as the bacillus tuberculosis, innocuous, cannot from the nature of the case yield perfectly harmonious results, which could only be expected if it were possible in each experiment to obtain precisely similar conditions. It is evident that some of these conditions in the case of experiments with tubercular virus are quite beyond our control. As will be found on reference to the tabulated results of these experiments, infective tubercular material subjected to the action of a certain temperature for a given time may on one occasion give a different result from that in another experiment carried on under apparently precisely identical conditions. If, then, the results obtained under apparently similar or identical conditions vary in this way, still greater confusion may be expected when we come to deal with those cases occurring as a result of the exhibition of material heated to different temperatures and for different periods of time.

It may be well here to indicate briefly the explanation of some of those variations, and why, probably, they are so marked and important in connexion with tuberculosis.

The importance of this in consideration of the results recorded.

Attenuation necessitates the use of a larger dose of the virus.

Difficulties in the way of applying this to tuberculosis.

In the case of an acute infective disease such as anthrax, a single bacillus appears to be sufficient, under certain conditions, to set up the disease in a very susceptible animal such as a mouse. As this organism is attenuated (as is seen exemplified in the case of Pasteur's vaccines), larger and larger doses are necessary to infect the animal until the "completely attenuated" stage is reached, in which condition still larger quantities of the organism may be introduced into mice without producing any appreciable effect. It is, however, in the case of the bacillus of tuberculosis much more difficult to determine at all accurately the exact number of bacilli required to infect an animal, as it is here impossible to make use of the methods of plate cultivation for the purpose of enumeration, as may be done in the case of the anthrax bacillus. Wyssokowitsky (*) has, however, experimented in this direction by counting the number of bacilli present in cover-glass preparations made from a drop of a diluted specimen of sputum. From experiments he concludes that from 8 to 30 virulent bacilli introduced into the peritoneal cavity are necessary to bring about infection of a guinea-pig (in rabbits 8–40 injected either subcutaneously or into a vein produced no evidence of tuberculosis), and from various other sets of experiments we are warranted in believing that a somewhat larger number is necessary when introduced subcutaneously. These results are rather vague, and are also rendered incomplete, inasmuch as no note is taken of the grade of virulence of the organisms experimented with. Indeed it is impossible at present to get reliable evidence as regards the exact virulence of any specimen of the bacillus tuberculosis owing to our inability to state the precise number of bacilli with which experiments are being carried on, and of course a larger number of weak bacilli might produce the same result as a smaller number of the more virulent organisms. Wyssokowitsky's results, however, indicate clearly that only a few virulent bacilli are necessary to infect guinea-pigs, results strongly confirmed by the fact which has so frequently been observed, that milk from tuberculous cows in which, as no bacilli could be demonstrated microscopically by other observers, the number present must have been very small, could still induce infection.

Precise activity standar activity tubercle bacilli n yet deci

The precise number of active tubercle bacilli introduced, or even their exact quality or virulence, is not usually thought to be of much importance in ordinary laboratory experiments which are usually carried out on the susceptible guinea-pig or rabbit, but when the bacilli are considerably modified and weakened, as in the case of "sterilisation" experiments where the bacilli are exposed to higher temperatures than those to which they are usually subjected in the animal body, the influence and importance of this factor at once becomes apparent. In exemplification of this, some of the earlier results of this investigation, obtained before the importance of this factor had been fully recognised, may be cited.

Importa of quant (concen tion).

In one series of experiments (Table CV., Part XIII., p. 247, *et seq.*) the material used was sound milk which had been mixed with the tubercular spleen and liver of a guinea-pig. That there could not have been many bacilli present (owing partly to the comparatively small number of tubercle bacilli met with in most cases of tuberculosis in the guinea-pig, but probably also to the fact that tubercular organs were not properly broken down and distributed) is shown by the fact that the control animals died, one each in 39 days and 41 days, but one lived for 95 days, this being an almost unprecedented period for a guinea-pig to survive an intraperitoneal injection of raw tubercular material.

The "sterilisation" by heat was carried on at a temperature of 60° C., for varying periods up to 35 minutes (*see* Table CV., p. 248 and 249) but not one single animal became infected with tuberculosis, although, as subsequent experiments proved, every animal would probably have succumbed had there been present a larger quantity of the infective material in this artificial tubercular milk.

Influenc of heat i modifyi effective dose of tubercul material

Evidence of this same modifying factor, the action of heat on a small number of bacilli, is brought out still more strikingly in the earliest milk experiments in which the milk was exposed to a temperature of 50° C. In these experiments the first material (No. 1. of Table CIII.) was shown to be capable of inducing tuberculosis in guinea-pigs when injected intraperitoneally after being heated for four hours, although at the end of eight hours of similar treatment it did not set up tubercle in a single instance.

Different results obtained at the sa tempera-ture.

The second material used (Material No. 2 of Table CIII.), was, on the other hand, capable of infecting guinea-pigs, even after it had been subjected to this temperature (50° C.) for 12 hours, whilst it was quite ineffective after being heated for 48 hours.

The exact point of sterilization therefore lies somewhere between these two margins.

The next material (No. 5 of Table CIII.), which was used for injection purposes at this temperature, was probably not so virulent as the second, inasmuch as it did not produce tuberculosis after being exposed to 50° C. for 12 hours, but, on the other hand, this may be due to the fact that the animals were not allowed to live for a sufficiently long time to show tuberculosis, as at the end of 61 days the experiments had to be brought to a close. On the first occasion on which material so treated was used, the animals infected with it died only after 117 days, and the others were killed at the same date, so that it is quite possible, though not probable, that at the end of 61 days, even in cases which might ultimately have given positive results, the evidences of the presence of tubercle might still have been wanting.

Prolonga tion of th course of the disea

The prolonged course of the disease when the material has been weakened by being exposed to an unfavourable temperature, was one of the most formidable difficulties that had to be encountered in carrying out these experiments, as the animals had to be retained under observation for such lengthened periods, occupying cages the while, that they interfered greatly with the starting of new sets of experiments, devised to confirm and extend the results obtained with infective material heated between the limits of temperature and time marked out in the previous series.

The reaso for makin repeated injections as well as repeated feedings.

It was as a result of the data obtained in the earlier experiments, and from taking into consideration the fact that the virulence of different material varied so greatly that the practice of subjecting animals to several inoculations of different materials heated at the same temperature and for the same period was adopted, so that each animal might run the gauntlet of several injections, one of which at any rate should be effective if such material were at all likely to produce tuberculosis under ordinary conditions.

(*) Trans. Internat. Med. Congress, Berlin. 1890, Bd. II., Abt. 3. p. 171.

It may be well to quote here some instances from the series of experiments carried out with material subjected to a temperature of 50° C., illustrating the manner in which the course of the disease was prolonged. Two control animals, which received the artificial tubercular milk in its raw condition, died after 26 and 50 days respectively, while those that had received the same material, after being heated at 50° C. for one hour, died at the end of 63 and 74 days respectively. When the material had been heated for 12 hours at this temperature, a still more marked influence is perceptible, one of the animals dying on the 73rd day and another on the 117th day, at which date two were still living but were then killed, both being found to be tubercular.

These experiments were not carried out with natural tubercular milk (that is from a cow with a tubercular udder), but with milk to which tubercular material had been added.

It may here be convenient to refer to some of the difficulties encountered in carrying out the experiments with this material, and to mention some of the anomalous results which occurred owing, perhaps, to the method of experimentation.

In ordinary tubercular milk the bacilli are usually lying free in the fluid, and are fairly equally distributed throughout.

As a natural result, animals which receive inoculations of similar quantities of the same batch of milk react as if they had received equal quantities of the virus, and one is accustomed to find that they die off within a day or two of each other. Thus, four guinea-pigs, which received intraperitoneally 1 cc. of the milk from Cow No. 21, died in 28, 29, 30, and 32 days respectively. (Part XII., Table C., p. 225, Controls.)

Three guinea-pigs, which received 5 cc. intraperitoneally of the raw milk from Cow 25, died, one in 22 days and the other two in 25 days after injection. (Part XII., Table CI., p. 226, Controls.)

Turning now to the experiments in which the material used consisted of sound milk, to which minced tubercular organs had been added, a very different state of affairs is met with; thus, out of a set of six control guinea-pigs which received each 2½ cc. intraperitoneally, only two developed tuberculosis, all the others escaping. In another case three guinea-pigs, which received each 2½ cc. intraperitoneally (Part XIII., Table No. CV., p. 247), died in 39, 41, and 95 days respectively.

The different manner in which the guinea-pigs reacted to equal quantities of the milk, to which apparently equal quantities of tubercular material had been added, compared with the uniform results obtained in guinea-pigs which received similar quantities of the natural tubercular milk, must apparently be referred to the equable distribution of the infective material in the latter case, and its unequal distribution in the former.

The difficulty of breaking down the tubercular material (which consisted usually of tubercular organs of cows, guinea-pigs, and pigs), into such a fine state of subdivision as occurs in the milk drawn from cows with tubercular udders, is naturally very great if indeed such breaking down is not absolutely impossible of achievement. In the earlier experiments this factor was not sufficiently recognised, and, as just pointed out, some of the control animals escaped infection, but, in the later experiments, only the material which had been passed through a fine wire sieve was used for experimental purposes. Even in this condition, however, the distribution attained cannot for a moment be compared to that which exists in the milk from a tubercular udder, the bacilli being mixed up with so much tissue or degenerated material, material which has a constant tendency to fall to the bottom of the fluid and to carry down the bacilli along with it.

In order that the conditions present normally in infective milk might be approximated as closely as possible, some of the experiments were made with sputum from cases of phthisis, mixed thoroughly with the milk; here, undoubtedly, the relation of the bacilli to the milk would approximate very closely to that holding in natural tubercular milk or milk from a tubercular udder. The difficulty of manipulating a sputum so that it becomes thoroughly incorporated with the milk, though usually very great, was found to be by no means insuperable. It may also here be pointed out that such milk was apparently not nearly so virulent as the material that had been made from tubercular organs. This may possibly be accounted for by the fact that the latter contains a larger number of bacilli, but another factor has also to be considered, as will be seen from the accompanying tables; the artificial tubercular milk required a much higher temperature and much longer periods of heating to render the inoculations ineffective. This may be due not merely to the number of bacilli present, but also to the conditions under which they are subjected to the process of heating.

Effect of presence of albuminous fluid in tubercular milk.

The bacilli present in the natural milk or in sputum are lying free and exposed directly to the action of the heat, whilst, in the case of the infective material derived from tubercular organs, the bacilli are in most cases protected, to some extent, by the cells of the tissues of the organs from which they are derived, and by the albumen of these, which, undergoing coagulation, forms a non-conducting covering. It is very probable that this factor exerts a very marked influence on the results of the experiments. Moreover the amount of free albuminous material present even in milk (especially in the milk obtained towards the end of the milk-giving period of a cow with a tubercular udder), would undergo coagulation at the higher temperatures employed, and by bringing about the enclosure of the organisms in an albuminous capsule, would exert a very similar influence. There is of course, in natural tubercular milk, a certain amount of serum albumen which would come into play in a similar manner, though probably its influence would be exerted to a less extent; when the milk is heated up to a certain temperature this albumen coagulates and falls to the bottom of the fluid, probably carrying down along with it the bacilli which in consequence are more or less protected from the action of the heat. In the case of advanced tubercular disease of the udder, the amount of serum albumen present is frequently so large that the milk may become quite solid, a condition which was very well seen in the milk of Cow No. 21, taken during the later stages of the udder affection.

Effect of presence of serum albumen in cases of advanced tuberculosis of the udder

May account for unequal results obtained with heated milk.

It may be that this is the explanation of the fact that only a certain proportion of the guinea-pigs which were inoculated with milk exposed to the action of heat developed tuberculosis, although it must be borne in mind that the settling process and coagulation would also tend to bring about an unequal distribution of the bacilli, a condition which might give rise to a similar series of results; thus, of three guinea-pigs which received intraperitoneally 1 cc. of the milk from Cow No. 21, heated at 60° C. for 15 minutes, two developed tuberculosis, whilst one escaped. Of three guinea-pigs that received, in the same manner, similar milk heated up to the same temperature for 30 minutes, only one developed tuberculosis while two escaped. A similar result is frequently observed in other cases, as will be seen on reference to the tables. On the other hand, it will be observed that, without exception, the raw milk gave rise to rapidly developing tuberculosis.

Regular results obtained with raw milk.

Importance of Feeding Experiments.

Importance of feeding experiments.

188 Up to the present, infection, as it occurs as the result of inoculation has been specially considered, but attention must now be directed to the conditions under which tuberculosis is acquired as the result of the ingestion of tubercular material. This is naturally the more important as it is the method with which we are practically concerned as being the only one by which tubercle can be acquired from the use of milk or meat derived from tuberculous animals. The inoculation experiments, in fact, serve merely more or less as a control of the feeding experiments, as affording us a working margin, and as indicating with greater certainty the limits of the possibility of infection by feeding, inasmuch as heated tubercular material will infect guinea-pigs by inoculation after it has become quite ineffective in feeding experiments in the same animals, though, as already seen, this does not apply to ingestion experiments carried on with pigs.

Conditions of infection in feeding experiments.

The conditions which come into play in an infection through feeding are quite different from those which maintain in infection by inoculation. These conditions exert an important influence on the probability of infection, and the course of the disease which may ensue. It has already been stated that a certain number of bacilli (8 to 30) are necessary to produce tuberculosis by intraperitoneal injection, but this does not apply in the case of the feeding experiments. In an inoculation experiment it may be accepted that all the bacilli which have been introduced come into operation in the attack on the tissues, but in the case of a feeding experiment it must be concluded that only a very small proportion of the bacilli actually ingested are taken up by the cells of the alimentary tract. It is not indeed a very unusual occurrence to observe that the tubercle appears to have originated in, and spread from, a single Peyer's patch or solitary gland which has become infected.

Few bacilli necessary to produce tuberculosis.

Analogies met with in anthrax.

In the case of milk where only a few bacilli are usually found lying together, it is improbable that more than these have taken part in such an infection. In support of the conclusion that a very small number of bacilli are sufficient to induce tuberculosis in guinea-pigs by feeding, if the material be in a sufficiently minute state of sub-division, may be quoted the results of many observers, who, using largely diluted milk and sputum, still obtained positive results. There is indeed no reason that we should be surprised that very varying quantities of infective material should be required to produce infection according as the tissue through which the bacilli gain admission to the organism varies. It has long been known, for example, that cattle which have been rendered completely refractory by inoculation to anthrax may still succumb when fed with anthrax bacilli, although the quantity of infective material actually absorbed from the alimentary tract must in many instances be much smaller than that which is present in the wound in the case of inoculation. On the other hand it has been proved that animals such as mice and guinea-pigs, which are the most susceptible of all animals to anthrax by inoculation, can ingest large quantities of the most virulent anthrax poison without being in any way affected by it. It may be necessary to return to a consideration of the question of the specific receptivity of different animals to different methods of infection, but it is here referred to as a probable explanation of how smaller quantities of virus may in certain instances suffice to infect from the alimentary tract than are necessary for infection by inoculation.

Importance of fine state of division of tubercular material in feeding experiments.

Attention has already been drawn to the difficulty which was experienced in breaking down the various tubercular organs and tissues to the fine state of sub-division necessary to bring the bacilli into a condition corresponding to that in which the tubercle bacilli occur in milk from a cow with a tubercular udder; this was of importance in the case of injection experiments, but, as was ascertained, it was still more necessary in connexion with the experiments carried on to induce infection by feeding. This was, no doubt, due to the fact that the particles of tissue which were attached to the bacilli interfered considerably with the absorption of the tubercle bacilli from the alimentary tract.

Feeding experiments with the raw milk from a tubercular udder were in all cases much more definite in their results than were those carried out with the artificial tubercular milk, although, in all cases, much larger numbers of tubercle bacilli had been added to the milk than could possibly be present in that drawn from a tubercular udder.

Phthisical sputum used in some cases.

Sputum was used in some of the feeding experiments as affording the nearest approach to the conditions found in the "natural" tubercular milk, but unfortunately the septic organisms so often met with in sputum interfered greatly with the success of these experiments.

Attenuation of tubercle bacilli. Larger number required to produce tuberculosis.

Shorter period of heating required to render material innocuous for feeding than for injection.

Notice has already been taken of the fact that as the bacilli are weakened or attenuated the number introduced must be largely increased in order to produce the same effect. As above suggested, however, the amount of infective material which is actually absorbed from the intestinal tract must probably be much smaller than that which comes into operation in an inoculation experiment. It would accordingly be expected that a much shorter period of heating would be required to render tubercular material ineffective in feeding than is necessary to effect the same result where inoculation is resorted to:—Such is indeed the case. Thus guinea-pigs develop tuberculosis on being fed on artificial tubercular milk after it has been kept at a temperature of 50° C. for only four hours, whereas the same material was still capable of inducing infection by inoculation when it has been subjected to similar conditions for as long a period as 12 hours. Similarly, material which has been heated at 55° C. for $1\frac{1}{2}$ hours, but nothing beyond this, gives positive results in feeding experiments, whilst on injection the same material which has been subjected to the same temperature for four hours still produces tuberculosis. These results, which are of pretty general application, would appear to indicate that material which has been heated long enough to render it inoperative when introduced into the alimentary canal usually requires to be heated about three times as long to become ineffective when introduced intraperitoneally.

Influence of gastric juice on tubercle bacilli.

There is another factor of which no notice has yet been taken, but which undoubtedly may play a certain rôle in rendering the virus which has been heated less effective by feeding than by inoculation, *i.e.*, the influence of the gastric juice. It has been shown that when tubercle bacilli are exposed to the action of a fluid made up of constituents corresponding to those of the gastric juice, at the temperature of the animal body, during a period such as that which would normally come into operation in the intestinal tract, although the bacilli are not actually killed, yet when they are injected into an animal they set up an attack of tubercular disease which runs a very prolonged and quite abnormal course; this modification of the disease is attributed to a temporary weakening of the virulence brought about by the action of the acid in the gastric juice on the Bacillus tuberculosis. This attenuating influence is frequently, no doubt, not very marked, as was found in the case of feeding with raw tubercular material. This may, in some few instances, perhaps, be ascribed to the fact that the bacilli are exposed for a very short time to the action of the acid, but it may also be due to the fact that although the organism had been weakened, the effect of this attenuation does not come into play so markedly, owing to the fact that the tissue of the alimentary tract is so susceptible to infection that the slight devitalising influence which has been exerted on the microbe is completely masked. Although the action of this factor above noted is never so marked as to prevent infection in the case of raw material, it may be readily understood that when the bacillus has already been weakened by the application of heat the addition of this new devitalising factor being made, may produce the same effect as a prolonged continuation of the heating process in rendering the virus innocuous.

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In experiments on animals we have, to a certain extent, a means of eliminating the influence of the gastric juice by observing the points of the alimentary tract from which infection has taken place. If the virus has been rendered innocuous owing to the action of the gastric juice, it might be expected that the tonsils and upper straits of the alimentary tract would be most readily infected, while the lower portions of the alimentary tract would remain intact.

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Leucocy of guine pig do n take up bacilli s readily do those the pig.

Relative suscepti- bility of and guin pig to ra and to heated tubercula material.

In the case of guinea-pigs, it has been impossible to make out a distinct case of tuberculosis in which the point of infection has been limited exclusively to the pharyngeal adenoid tissue which, however, have undoubtedly been attacked along with other parts of the alimentary tract; but in the case of pigs the infection from this point is frequently very well marked. A pig which has been fed on raw material frequently, in fact usually, exhibits distinct evidence of infection, not merely in the tonsils, but along the whole intestinal tract; but where the material has been heated up for a certain time, the infective process is always more marked in the tonsils and glands of the neck than elsewhere, and in some cases it is almost limited to this region. In guinea-pigs the pharyngeal adenoid tissue is not specially liable to be affected even with raw material, unless this has been taken in large quantity, so that we can hardly expect these to be picked out when the virus has undergone a process of attenuation. This is, no doubt, to be ascribed partly to the condition of the glands in this animal, and to the function which they are in the habit of performing. In the case of the pig the tonsils are developed to a very extraordinary degree, owing to the nature of the food which the animal is accustomed to ingest, and from the large number of leucocytes which are constantly thrown out, which have the power of taking up the tubercle bacillus, and also to the constantly abraided condition of the mucous surface, the liability to infection of the pig in this region is, no doubt, largely increased. This liability to infection may, however, depend not merely on the presence of a large number of leucocytes, but also on the capacity of these to take up the bacilli and carry them back with them into and beyond the intestinal walls. It would appear that the leucocytes of the guinea-pig very seldom absorb tubercle bacilli, and when they do so, they seem to disintegrate very rapidly, whereas, as is often observed on microscopical examination, tubercle bacilli are very frequently found within the cells of the pig. It may, perhaps, be owing to this property of an apparently more resistant animal, such as the pig, that they are more susceptible to the weakened virus than the more susceptible guinea-pig. As already pointed out, positive results were frequently obtained in pigs when guinea-pigs, fed on precisely the same material (tubercular milk heated to various temperatures and for various times) escaped unharmed. Indeed, the results obtained, as a whole, would raise the suspicion that guinea-pigs are not so well suited for experiments with weakened material as one would expect from their great susceptibility to the action of the raw virulent material, *i.e.*, that positive results might sometimes have been more readily obtained on an apparently less susceptible animal, such as the pig.

Fallacies to be guarded against in studying Local Tuberculosis.

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189 In making up one's mind as to whether an injection of tubercular material which has been heated up to a given temperature for a certain time has given rise to infection or not, one is confronted by a difficulty which has undoubtedly misled earlier observers in those cases where the lesion happened to be only local. Several of these observers have recorded cases where local tuberculosis has been developed even when the tubercular material before inoculation had been heated to the boiling point, and retained at that temperature for some time. In view, however, of the experiments(¹) which have established the fact that the dead bodies of the tubercle bacilli can set up local tissue changes precisely similar and analogous to those set up by the living organism, all those cases which depend upon local evidence alone as stamping them as tubercular must be regarded as insufficiently proved. It would be necessary in all such cases to reinoculate another animal from the first to prove the true infectivity of this material. This difficulty would naturally be met with most frequently when the inoculation was made subcutaneously where the bacilli introduced would be caught in the first lymphatic gland. As, however, almost all our sterilisation experiments were tested by intraperitoneal injection, where the bacilli introduced are spread over the different organs of the peritoneal cavity, there was much less risk of being misled in this manner. As in many cases large quantities of tubercular material were used in the injections, the mere presence of tubercle bacilli in the neighbourhood of the point of their introduction was never regarded as a proof that the animal had become infected, as it has been shown that the dead bacilli may be demonstrated microscopically in the tissues for a considerable time after the injection has been made. In no sterilisation experiment was the presence of local tuberculosis regarded as a proof of the virus being still "infective," unless other animals of the same set gave evidence that the virus was spreading in the animal body.

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In comparing the results obtained by inoculation and feeding experiments on animals with those which have been recorded by careful observers as regards the time and temperature required to inhibit the powers of growth of the tubercle bacillus in pure cultures, one is at once struck by their want of similarity. Thus it has been found that pure cultures of tubercle bacilli refuse to grow on being transplanted to glycerine agar (1) after being held at 60° C. for 20 minutes; this or a similar result has been obtained by several observers; (2) on heating up to 70° C. It may, however, be readily understood that the tubercle bacillus, which always grows somewhat tardily upon one of our artificial media, may, when it has been subjected to a devitalising influence sufficient to hinder its growth on artificial media, still be able to develop when introduced into its normal habitat (the body of a susceptible animal), and this must, without doubt, be held to be the explanation of this apparent discrepancy.

Problems to be solved.

190 In considering the results obtained in the experiments carried on with milk from cows with tuberculous udders, and with artificial tubercular milk, the fact should never be lost sight of that there were practically two distinct questions that had to be answered:—

(1.) The relative virulence of milk from tuberculous udders, and the conditions under which such milk might be rendered innocuous; and

(2.) The conditions under which extremely virulent and concentrated artificial tubercular milk could be so modified by heat that it might be given with impunity, either by feeding or injection, to animals of varying degree of susceptibility to infection by tubercle.

Effect of dilution of Milk.

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191 In the first part, dealing with tubercular milk, there is ample evidence to show that the virulence of different milks varies in a most marked manner, a variation that could be more or less distinctly measured, first of all by injection and feeding experiments on guinea-pigs, secondly by the length of exposure to certain temperatures required to render it harmless. Thus, in one series of control experiments the milk from Cow No. 24 (Part XII., Table CII., p. 227), though infectious when injected into guinea-pigs, produced no results when ingested by these animals. In another case, the raw milk from Cow No. 20, Part XII., Table XCIX., p. 222 and 223, proved fatal (setting up tuberculosis) to the guinea-pigs, both by feeding and injection, but a comparatively short exposure of this milk to a temperature of 70° C. rendered it perfectly innocuous also to guinea-pigs either by feeding or injection; whilst, as will be seen on reference to Table No. C., p. 223, *et seq.*, the milk from Cow No. 21 was of such a virulent character that it remained infective to guinea-pigs after being exposed for 15 minutes to a temperature of 70° C. There can be little doubt that this variation is in great part dependent upon the dilution of the tubercular milk (and to the action of heat upon it), and as has already been indicated by Bollinger and others in most elaborate series of experiments the admixture of fresh milk even with the most virulent tubercular material drawn from the udder of a cow in an advanced stage of tuberculosis might be so diluted that it was no longer capable of setting up tuberculosis either by ingestion or by injection, the two theories given in explanation of this being (1) that the material is so diluted that the animal never receives a sufficiently large number of bacilli to constitute an infective dose; or (2) that the milk serum in a fresh condition exerts an active germicidal influence on the tubercle bacilli, and thus renders them innocuous after a certain dilution of the milk is attained, a certain amount of serum being required to exert the full germicidal action on a definite number of tubercle bacilli. Until these experiments have been repeated, with pigs as the animals experimented on, it will be impossible to obtain much more light on this question than has already been published, but the fact must be accepted that a certain dilution of tubercular milk renders it incapable of setting up tuberculosis in small rodents such as rabbits and guinea-pigs.

Effect of dilution tubercular milk.

Experiments carried on with "milk" not with the sediment obtained from milk.

In many of the experiments that have been previously carried on to determine the infectivity of milk, the milk itself has only in certain cases been used as the infective agent. In Bang's admirable series of experiments, which were carried out rather to determine the presence of infective material in milk, than to determine the infective power of the milk, many of the experiments were carried on with a sediment obtained from milk that had been allowed to stand, or that had been centrifugalised. In our experiments, however, this sedimentation was not resorted to, and in many cases an additional quantity of healthy milk was added in order to bring the milk used into a condition more nearly resembling that in which it would be supplied in the milk market. It appears to be partly for this reason, but also partly from the varying number of bacilli met with in samples of milk taken from different cows with tubercular udders, that such variable results were obtained in our experiments, but when all these factors are taken into consideration, and when every allowance has been made both for the effects of dilution and for the action of the milk serum on the tubercle bacilli, the fact cannot be ignored that even the least virulent material with which we worked was sufficiently active to render it a source of very great danger to the community, if not subjected to some process of sterilisation by heat, for although the least virulent milk could be easily sterilised by a short exposure to a very moderate temperature, it was, before such exposure to heat, sufficiently virulent when injected into guinea-pigs to set up tuberculosis, and from what has been observed as to the relative infectivity between injection of a tubercular material into the guinea-pig, and ingestion of the same material by the pig, it may be argued that this least virulent material was still sufficiently active to set up tuberculosis in pigs, even when taken into the alimentary canal. This is a fact which should not be lost sight of, especially when the resemblances between the peri-pharyngeal tubercle of the pig and the scrofulous glands of the neck of the weakly child are taken into consideration. When, however, as is seen on reference to Table C., Part XII., p. 223, *et seq.* the milk has a still greater virulence, a virulence which can only be got rid of by exposing the milk to a high temperature for a comparatively long period, the gravity of the case is accentuated, and so long as such material can by any possibility find its way into a milk supply, so long must there be a very appreciable danger of the production of tuberculosis in the human subject, especially in weakly children, arising from this source, and so long should

All the samples of milk taken from tubercular udders distinctly dangerous.

Some only slightly so.

Others much more distinctly so.

Necessity for adopting method of sterilisation by heat.

(¹) Reports of the College of Physicians, New York for 1891. Hodenpyl and Prudden. *See also* New York Medical Journal, June 6th and 20th and December 5th, 1891.

instructions be given for the sterilisation of milk before it is used.

PRECAUTIONS TO BE TAKEN IN CONNEXION WITH MILK.

Method advised.

192 As many people object very strongly to the taste of milk that has been subjected to boiling, some method of heating or scalding should be adopted which reduces to a minimum this peculiar taste. The following table will assist those interested in the subject in determining the point at which milk so heated may be considered as no longer dangerous. This heating, however, can only be a temporary expedient, and one which must be resorted to by consumers in their own interest, and to protect themselves and their children against what is a very definite and real danger, but the danger should be met at a point not only before the milk comes into the hands of the customers, but before it is possible to get into the hands of the dairy-keepers, and this can only be done by having recourse to a well-organised system of inspection of all cattle on every dairy farm.

Heating a mere temporary expedient.

Veterinary inspector of dairy cattle the great safeguard against spread of tuberculosis by milk.

Heating of Milk.

Method of scalding milk.

193 It has already been noted that exposure of even virulent tubercular milk to a temperature of 85° C. for five minutes is sufficient to render it innocuous even when injected into the peritoneal cavity of a guinea-pig, although the same material when rapidly brought up to a temperature of 90° C. still remains capable of infecting guinea-pigs by injection. It is evident, therefore, that in order to ensure complete sterilisation of milk it should be maintained at a comparatively high temperature for a lengthened period, but this temperature should never be so high that the peculiar mawkish taste imparted to milk by boiling is acquired. In order to steer clear of this peculiar taste many householders place the milk in an earthenware jar or tin pannikin, place this in a pan containing a quantity of water and bringing this up to the boiling point, think that such treatment is sufficient to sterilise it.

Mawkish taste due to use of too high a temperature.

Details of method. Experiment No. 1.

In order to test how far this is an efficient method of treatment the following experiments were carried out:—A quart of milk in a common earthenware jug was placed in a two-quart pan containing about a quart of cold water, so that the quantity of water was about equal to the quantity of milk, and when the jug was in position the pan was full; the temperature in both milk and water was about 15·5° C. These were then placed over a Bunsen burner and heated up rapidly. The following table gives the temperature attained in the milk at different periods up to 26 minutes in the first case, and every five minutes up to 25 minutes in the second.

194 TABLE LXX.

Temperatures attained during the Scalding of Milk.

Time.		Experiment No. 1.	Experiment No. 2.
		° C.	° C.
3 minutes	-	22	—
4½ minutes	-	26·7	—
5 minutes	-	—	41
6 minutes	-	32·2	—
7 minutes	-	37·8	—
8 minutes	-	41	—
9 minutes	-	43·3	—
10 minutes	-	48·9	68
11 minutes	-	60	—
12 minutes	-	65·6	—
14 minutes	-	71·1	—
15 minutes	-	75·6	76·7
16 minutes	-	76·7	—
17 minutes	-	79	—
18 minutes	-	82·2	83·3
19 minutes	-	85	—
20 minutes	-	86	86·7
21 minutes	-	87·8	—
22 minutes	-	88 9	87·8
23 minutes	-	91	—
24 minutes	-	91	—
25 minutes	-	91·1	91
26 minutes	-	92	—

Different results obtained in two experiments.

It will be seen that in the first experiment at the end of 14 minutes, a temperature of 71° C. had been attained, so that for the remaining 12 minutes of the experiment at least, the milk within an inch or an inch-and-a-half of the surface was exposed to a temperature of between 71° C. and 92° C., a temperature which it is safe to say will destroy any tubercle bacilli, or in fact any germs (not spore bearing) which might be contained in milk, and would have rendered innocuous even very large numbers of tubercle bacilli had they been present in this milk. It must be pointed out, however, that the thermometer placed at the bottom of the same milk only recorded 56° C. at the end of 14 minutes, though two minutes later this had risen 10° C.; at 18 minutes it had risen to 72° C., at 23 minutes to 81°·5 C., and at 26 minutes to 83°·5 C., so that although the bulk of the milk had attained a temperature of over 90° C. a certain proportion of that near the bottom had only reached 83° C.

and diffe nt laye of milk

Exp No.

The second experiment was carried out in the same utensils and under exactly the same conditions except that a rather fuller gas flame was used, and that the temperatures were taken only at intervals of 5 minutes up to 15 minutes, and then every two or three minutes up to 25 minutes. This second experiment was exceedingly instructive as indicating the conditions under which milk should be sterilised. At the end of five minutes' heating the temperature of the milk had risen to 41° C., as compared with about 30° C. in the previous experiment; at the end of 10 minutes it had risen to 68° C. (at which point the water boiled), as against nearly 49° C. in the previous experiment; at 15 minutes the two temperatures were almost equal—76°·7 C. in the second experiment as against 75°·6 C. in the first—after which the rise continued up to 91° C. at the end of 25 minutes, being almost exactly the same as in the first experiment. But the most important point to notice is that the difference between the surface and bottom temperature of the milk was now reduced to a minimum, at the end of 10 minutes the two temperatures were the same at the top and bottom; at 17 minutes it was only ·3 of a degree lower at the bottom; at 20 minutes the two temperatures were again the same, 86°·7; and at 25 minutes they also remained the same. On being allowed to stand for 15 minutes, after being removed from the water the milk had cooled down only to 75°·6 C., and there was a difference of only one degree between the surface and the bottom temperatures.

Milk treat little taste

Milk so treated and allowed to stand in a cool place for a few hours has scarcely a trace of the taste that is so often described as characteristic of "boiled" milk, and is taken by children almost as readily as perfectly fresh milk, and when this milk has been kept for a few hours this taste has disappeared entirely. Those who have adopted this method of sterilising milk describe it, in fact, as doing away with the taste of the cow.

Conc nece to cr comp steri

It will be seen on comparing the records of the temperatures attained in the two sets of experiments that the hotter the flame the more regular is the temperature attained at different levels throughout the milk, whilst the heating of the milk goes on not only more rapidly but also more regularly throughout, and the milk is exposed to a much higher temperature throughout the experiment, although the temperature attained at the end of 25 minutes is practically the same in both cases.

Two other sets of experiments were made with a specially prepared milk pan, the outer pan holding about 2 quarts of water, the inner made of porcelain, holding a quart of milk. In the first experiment, No. 3, the upper pan was filled with a quart of milk, and a brisk gas flame was kept under it. In the second case, No. 4, only a pint of milk was placed in the inner receptacle, and a flame, only sufficiently large to keep the water just boiling, was kept under the pan. The following are the lowest temperature readings taken in these specimens:—

195 TABLE LXXI.

Temperature attained during the Scalding of Milk.

Time.		Experiment No. 3.	Experiment No. 4.
		° C.	° C.
1 minute	-	—	20·5
5 minutes	-	20	28·9
9 minutes	-	Water boils.	—
10 minutes	-	47	51·6 water boils.
12 minutes	-	—	62·7
15 minutes	-	70	71·1
20 minutes	-	78	77·8
22 minutes	-	—	83·3
25 minutes	-	83	86·1
27 minutes	-	—	87·2
30 minutes	-	84	88·3
32 minutes	-	—	88·3
35 minutes	-	85	88·5
37 minutes	-	—	88·5
40 minutes	-	86	88·5
45 minutes	-	87	Did not rise.
50 minutes	-	90	
55 minutes	-	91	
60 minutes	-	92·5	

Here again it will be seen that, although the water boils at 9 and 10 minutes respectively, the lowest temperature readings taken in the milk at 10 minutes are 47° C. in the one case, and 51·6° C. in the other, a temperature quite inadequate to render inocuous any tubercle bacilli that might be present in the milk. Here again the size of the flame has to be taken into account, as in Experiment No. 3, where the flame was intentionally turned somewhat higher, the temperature of the milk was four degrees higher than in Experiment No. 4, in which, although the temperature ran up more rapidly for a short time towards the end of the process, it never rose beyond 88·5° C. The amount of milk heated appears to make little difference as regards the ultimate temperature attained; but, as will be seen on a comparison of the temperatures between 22 and 50 minutes recorded in the two tables, the rise is much more rapid in the case of the smaller quantity than where a larger quantity is used.

These experiments bear out entirely the conclusions drawn from Experiments 1 and 2, that milk to be properly scalded and sterilised should be kept in the scalding pan for at least half an hour. In both Experiments 3 and 4 this would only just be sufficient to render it absolutely certain that the milk was sterilised, though sterilization might possibly have been complete at the end of from 20 to 25 minutes.

The temperature in Experiment No. 3 was taken at the surface, at the middle, and at the bottom of the milk, and it was sometimes found there was a difference of as much as 3½ degrees between the surface temperature and that near the bottom, but as the higher temperatures were reached this difference soon disappeared or was reduced to half a degree at the outside. I have, however, selected for the tables the lowest temperature obtained at any point.

The indications, then, for sterilising milk by this method are,—

uantity water.

(1.) That the quantity of milk should never be more than the quantity of *cold* water by which it is surrounded; it is an advantage, in fact, to have a somewhat larger bulk of water than of milk to allow for evaporation;

ilk not vered.

(2.) The milk should not be covered in, and should be stirred from time to time, but the water may, with advantage, be covered in order to prevent evaporation: this of course is arranged for in the special milk sterilising pans;

risk flame.

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(3.) The water should be boiled over a good brisk flame in order that the best results may be obtained, and the heating process should be continued until the temperature throughout the milk has risen to from 88° C. to 92° C.; in most cases this takes place at the end of about 25 minutes, but in order to be perfectly safe it may be recommended that every quart of milk treated in this fashion should be heated for half-an-hour, that is for about 20 minutes after the water in the outer pan has begun to boil.

One great advantage of this method of sterilisation is that after the pan is placed on the fire or gas-stove it needs little attention beyond an occasional stirring until the end of the half-hour.

Milk treated in this manner may be looked upon as "sterilised," and as perfectly innocuous even though it should contain the bodies of a considerable number of tubercle bacilli.

ere scalding" ot sufficent in the se of milk ntaining bercle acilli.

A very short consideration of the above tables and a comparison of the results there recorded, with those obtained in the sterilising experiments with natural and artificial tubercular milk will render it evident that the mere scalding of milk by bringing the outside water up to boiling point is quite inadequate to sterilise tubercular milk, as in the one case the temperature of the milk had only been brought up to 41° C. when the water boiled, and even in the other case, although the water had been boiling some time when the temperature in the milk was taken, at the end of 10 minutes it had only reached 68° C., both of these temperatures being quite inadequate to render the tubercular material, unless present in the most minute quantity, innocuous.

196 *Veterinary and Medical Inspection of all Dairy Farms and Dairies.*

Our veterinar surgeons would soo be competent to discharge the duties thoroughl

It has been suggested that it would be impossible to get a sufficiently large number of veterinary surgeons versed in modern pathological methods and sufficiently well trained in morbid anatomy and comparative pathology to carry out any thorough and systematic plan of inspection. After a careful study of a system of voluntary submission to inspection as carried out in Denmark and Sweden in some of the dairy farms there, and after a careful consideration of the course of training, and some experience of the examinations in pathology to which those students, who are entering the veterinary profession have to submit, I am thoroughly convinced that this objection is one that would readily be met, especially if some arrangement could be arrived at by which the veterinary inspectors of a district could co-operate with the medical officer of health.

There might, no doubt (though from experience of voluntary inspection in the above-mentioned countries, and even at home, I doubt whether this would be the case), be a certain number of farmers who might think that their interests would be injuriously affected by any efficient system of inspection, but such opposition would very rapidly be withdrawn when the true value of such inspection, not only to the consumer, but also to the farmer, was fully appreciated; indeed, even at present, many of the dairy companies and private farmers have so far given way to popular opinion that in the circulars sent round by them, asking for custom, a special inducement put forward is that the cows in these dairies are under the direct supervision of some medical man.

The expense of instituting such a system might in the first instance be considerable, but when even the small series of experiments that we have carried on has brought to light the fact that so many cows with tubercular udders are giving milk which is supplied (mixed with other milk, no doubt, and, therefore, deprived of *some* of its virulence) to consumers, such expense might fairly be incurred. A mere perfunctory and irregular inspection would certainly not meet the requirements of the case.

Voluntar inspectio of cattle farms of milk asso ciations c Denmark and Swed

In Denmark, where tuberculosis amongst dairy cattle is of very frequent and widespread occurrence, a fortnightly inspection is made on every farm, in certain voluntary associations, by the veterinary surgeon, and every fortnight all animals suffering from any form of disease pass through his hands, whilst every animal on the farm is inspected once a month. If such regular inspection can be of advantage in a country where so large a proportion of the wealth is derived from farming and dairying, and where in consequence the interests of producers must bulk so much more largely in proportion to those of the national consumer than in this country, and if these producers are not only willing but anxious to submit to inspection, how much less should inspection be shirked in this country.

Systemat inspectio necessar

Insidious nature of the disea

Rapidity of invasio of the udder.

I have spoken of frequent and systematic inspection by veterinary surgeons; it is often a very difficult matter to tell whether cattle are tuberculous or not, and in some instances before the use of tuberculin became general it was impossible to make out tuberculosis when confined to the abdominal and thoracic glands and to the serous membranes of these cavities, even in a fairly advanced stage, the general condition of the animal being all that there is to help the veterinary surgeon to make the diagnosis. It has also been pointed out that tuberculosis of the udder may develop, not only in well marked cases of tuberculosis, but also, in cases such as those above described, in which the udder lesion develops with extreme rapidity, that although indistinguishable at one visit of the veterinary surgeon it may be well developed on a second visit a fortnight later, this lesion in such a case being the first distinctly recognisable indication of tuberculosis in the animal. Should the intervals of inspection be greater than a fortnight the value of inspection would be enormously diminished as far as protection of the consumers of milk against what must now be recognised as a very grave danger goes. Beyond this, however, it has been pointed out that the tubercular lesion of the udder may occur at any period of the disease, not only when it has been localised to the glands or to special cavities, but also when the disease has become much more generalised. In view of these facts the following should be laid down as definite instructions to veterinary inspectors:—

Points to be borne in mind inspector

No tuber cular cow be allowe to remai in a dair supply.

(*a*.) That all tubercular animals, whether affected with udder disease or not, should be eliminated from a dairy supply, removed from the farm and slaughtered at as early a date as possible, it being pointed out to the farmer that every day that the animal lives diminishes the value of the carcase, the milk being no longer of the slightest value.

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(*b*.) That every animal suffering from *any* disease of the udder should be carefully isolated and milked after all the other cows have been milked, or by a separate milker; this milk should from time to time be carefully examined both chemically and microscopically. If used at all it should be carefully boiled, and only after such treatment should it be given to pigs or other animals, though the risk of doing this should be carefully pointed out to the farmer. Only after a certificate has been given by the veterinary surgeon in consultation with the medical officer of health, should the milk from any cow suspected of udder disease be allowed to pass into circulation.

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(*c*.) The registration of all dairy premises and of every animal bought for or sold from these premises should be carefully made out and kept by the veterinary inspector, and notes on the condition of every suspected animal should be entered up at each visit. Some system of notification combined with one of compensation would add enormously to the value of this system of inspection, and would greatly facilitate the working of the system. The method of diagnosis of tuberculosis in cattle does not come within the province of this investigation.

197 THE STERILISATION OF MARKEDLY TUBERCULAR MATERIAL.

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The second question to be answered in this report is under what conditions can tubercular material of known great virulence be rendered innocuous? In order to determine the answer to this question the material used was in many instances of much greater virulence than many of the "natural" tubercular milk that were used. It is impossible to determine the relative susceptibility of the human subject to tuberculosis, that is, to place the human subject in a definite position in the scale of susceptibility amongst animals, and it must, therefore, be assumed for all practical purposes that he is under certain conditions quite as liable to take the disease as the most susceptible animal used in our experiments. As infection may apparently take place from any part of the alimentary or respiratory tracts in animals, and as we find lesions in man which would indicate that he also is liable to infection from similar points, and under exactly the same conditions, it must be held that so long as tuberculosis can be produced in animals in any of the ways mentioned in this report, so long does this same material remain capable of setting up tuberculosis in the human subject.

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It will already have been gathered from a comparison of the feeding experiments made on pigs with injection experiments carried on with guinea-pigs, that so long as any material remains infective to a guinea-pig by injection so long or nearly so long does it remain capable of infecting the pig from the tonsils or some part of the pharynx, and, therefore, it must be held as capable of setting up similar lesions in the human subject. It is for this reason that the injection experiments assume an importance which is usually not assigned to them.

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sults.

Of the following tables, giving at a glance the results obtained by this extremely infective material that had been heated to different temperatures and for different times, one is devoted entirely to experiments on guinea-pigs in order that what may be spoken of as the constant factors might be as much alike as possible; the records of the results of experiments on cats and pigs are given in separate tables.

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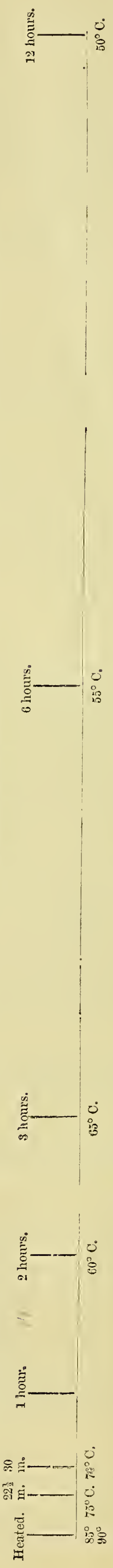
Tables Nos. LXXII. and LXXIII., give at a glance the outside limits at which infection was obtained; they are compiled from experiments made with materials of all degrees of virulence from the lowest to the highest that were used, and they indicate fairly well and also fairly regularly the temperature and time (during which the temperature is maintained), necessary to render such material innocuous to guinea-pigs by feeding and inoculation. The irregularity of the results obtained in the experiments at 60° C. and 65° C. (there being a rise instead of a fall at 65° C.), must be accounted for on the supposition that a more concentrated or more virulent material was used for

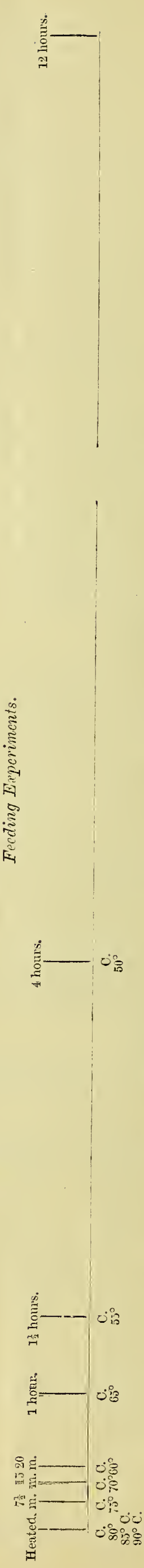
TABLE LXXIV.

TABLE TO SHOW LIMITS OF TIME AND TEMPERATURE AT WHICH POSITIVE RESULTS WERE OBTAINED WITH HEATED ARTIFICIAL OR NATURAL TUBERCULAR MILK.

Injection Experiments.



Feeding Experiments.



In both these tables 60° ought, naturally, to come somewhere between 55° C. and 65° C., but the results obtained make it necessary to place it between 65° C. and 70° C. This is evidently inaccurate, as positive results were obtained with milk heated to 65° C. for three hours and one hour respectively in the injection and feeding experiments. In the above scale 1 inch = 1 hour. The broken part of the line is supposed to represent the extra couple of inches and hours.

TABLE. LXXII.

SUMMARY OF RESULTS OBTAINED BY FEEDING GUINEA-PIGS WITH ARTIFICIAL TUBERCULAR MILK OR MILK FROM COWS WITH TUBERCULAR UDDERS.

	Simply heated to	2½ min	5 min	7½ min	10 min	15 min	20 min	25 min	30 min	35 min	45 min	1 hour	1¼ hours	1½ hours	2 hours	3 hours	4 hours	5 hours	6 hours	7 hours	8 hours	10 hours	12 hours	15 hours	18 hours	20 hours	21 hours	24 hours	48 hours
50° C.												+			+	+	+	−	−	−	−		−	−	−		−	−	−
55° C.											+	+	+	+		−				−		−				−			
60° C.			−		+	−	+	−	−	−	−	−			−						−				−				
65° C.	−	−	−		+	−	+	+	−		−	+			−		−				−								
70° C.	−	−	+		+	+	−		−		−	−		−	−														
75° C.	−			+		−																							
80° C.	−		−		−																								
85° C.	−	−	−	−																									
90° C.	−																												

+ Where experiments gave positive results. − Where experiments gave negative results. Where spaces are blank no experiments were made.

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TABLE. LXXIII.

SUMMARY OF RESULTS OBTAINED BY INJECTING GUINEA-PIGS INTRAPERITONEALLY WITH ARTIFICIAL TUBERCULAR MILK OR MILK FROM TUBERCULAR UDDERS.

	Simply Heated	2½ min.	5 min.	7½ min.	9. min.	10 min.	11 min.	12 min	15 min.	20 min.	22½ min.	25 min.	30 min.	35 min	45 min.	1. hour	1¼ hours	1½ hours	2 hours	3 hours	4 hours	5 hours	6 hours	7 hours	8 hours	10 hours	12 hours	15 hours	18 hours	20 hours	21 hours	24 hours	48. hours
50°C																+			+	+	+		+		+		+	—	—		—	—	—
55°C.															+			+		+	+	—	+	—		—				—			
60°C.			+			+			+	+		—	+	—	+	+	+	+	+						—				—				
65°C.	+	+	+			+			+	+		—	+		+	+		—	+	+	—				—								
70°C.	—	+	+		—	+	+	+	+	—			+		—	—		—	—														
75°C	+			+					+		+		—		—																		
80°C	—		—			—			—	—																							
85°C	—	—	—	—		—																											
90°C.	+																																

+ Where experiments gave positive results. — Where experiments gave negative results. Where spaces are blank no experiments were made.

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both feeding and injection experiments carried on at 65° C. than was used for the 60° C. series.

Feeding experiments.

Injection experiments.

The feeding experiments with guinea-pigs cannot be finally accepted as giving the limits of temperature necessary to sterilise either tubercular meat or milk for human consumption, but they afford most important information, whilst the injection experiments may be looked upon as affording most definite information on this point. It will be seen that the proportion of three to one, as regards the time of heating necessary to render tubercular material innocuous (*a*) by injection and (*b*) by feeding, is maintained throughout with fairly well marked regularity, and where the rise in virulence is marked in the sets of feeding experiments carried on at 60° C. and 65° C. a corresponding rise is seen in the injection experiments.

Results in graphic form.

198 Although these tables give the actual results, they not indicate in graphic form the effects of an increase in temperature in diminishing the time of exposure necessary to bring about the complete attenuation of the virus, but this may be easily seen on referring to the chart (Table No. XLIV.) in which the outside limits of time and temperature at which positive results were obtained are marked on a graduated straight line one inch being equal to an hour. Here the increase of temperature in diminishing the time necessary to render the milk innocuous in both feeding and injection experiments is brought out very distinctly.

199 Feeding Experiments with Pigs.

Most of pigs affected.

Evidence of attenuation.

Controls not necessary.

Case of bacterial necrosis.

On reference to Table No. LXXV., it will be observed that, with one exception, every animal that was fed with tubercular milk became tubercular. The experiments were carried on with milk maintained at different temperatures between 60° C. and 80° C. for times varying from one hour down to five minutes. Control experiments were always made in order that the degree of attenuation might be followed by comparing the disease as produced by raw tubercular milk, natural or artificial, with that produced by the same milk heated for the various times at the different temperatures. This does not come out in the table, but on reference to the descriptions of the various series of experiments (Part XIII.) it will be seen that this is brought out in a very remarkable manner, the course of the disease being prolonged and the extent of the infection diminished as the degree and time of heating were increased. It was not necessary to have separate control animals fed with non-tubercular material after it had once been proved in the first series that only those fed with tubercular material became affected, the hygienic conditions being distinctly favourable to the preservation of the health of the animals. Of the animals fed with the attenuated material, the one that remained unaffected died at the comparatively early period of 36 days, a period possibly too early for the development of tuberculosis from the attenuated tubercular milk; this animal, however, was found to be affected both in the stomach and in the cæcum by the bacterial necrosis figured in Plates Nos. V. and XX.

Importance of feeding experiments on pigs.

Necessity for prolonged heating in order to sterilise milk.

These experiments with pigs are specially important in so far as they bring out the fact that tubercular material remains infective for feeding after prolonged heating, at higher temperatures, than has previously been supposed; after much longer heating indeed than in the case of guinea-pigs in feeding experiments, and after fully as long, if not longer exposure to these comparatively high temperatures, when injection experiments are carried on with the same animals. They therefore indicate the necessity of carrying on the process of heating much further than is usually recommended in order to render such material perfectly innocuous to pigs, and therefore to remove all danger of human beings contracting the disease when this same material is used. It is unnecessary to enter into this question further, having drawn special attention to the same point at other parts of the report.

200 TABLE LXXV.

Feeding Experiments with Pigs, using Artificial Tubercular Material heated to different Temperatures for various Times.

Temperature.	Heated to	5 min.	2½ min.	10 min.	15 min.	20 min.	30 min.	40 min.	45 min.	1 hour.
60° C. -							+			+
65° C. -						+		+		
70° C. -			+		+		−		+	
75° C. -		+		+	+					
80° C. -		+		+						

+ = Where experiments gave positive results.
− = Where experiments gave negative results.
Where spaces are blank no experiments were made.

201 Feeding Experiments with Cats.

Only few experime carried o

In Table No. LXXVI., in which are set forth the few experiments that were made on cats, nothing comes out more remarkably than the extreme irregularity with which cats are affected, and on reference to the few positive results obtained it may be readily understood how it is that so many observers have been unable to satisfy themselves that tuberculosis could be induced in cats by feeding, but having in mind the fact that it could be so readily induced in cats by injecting raw tubercular milk into the peritoneal cavity, and finding, too, that feeding young cats with raw artificial tubercular milk as well as the raw milk from cows with tubercular udders very frequently set up tuberculosis, it was thought advisable to push the experiments further and to see whether it was not possible to obtain some cases of infection by feeding young cats with the heated tubercular milk. It is evident from the four positive cases obtained out of these experiments that tubercular milk even when heated to 75° C. for 15 minutes or to 50° C. for three hours may still remain capable of setting up tuberculosis in young cats; in older cats it is a much more difficult matter to produce tuberculosis, even with the raw material, but with the younger animals there can be no doubt that positive results are fairly easily obtained. This factor of age also should be borne in mind in connexion with the affection of young children by tuberculosis as a result of ingesting tubercular milk or other material either raw or in a partially sterilised condition.

TABLE LXXVI.

Feeding Experiments with Cats and Kittens, using Artificial Tubercular Material heated to different Temperatures for various Times.

Temperature.	Simply heated to.	5 min.	10 min.	15 min.	20 min.	30 min.	45 min.	2 hours.	3 hours.	4 hours.
50° C. -								−	+	−
60° C. -				−	−					
65° C. -			−		−	−	−			
70° C. -						−				
75° C. -	−	+	+	+						
80° C. -	−	−								

+ = Where experiments gave positive results.
− = Where experiments gave negative results.
Where spaces are blank no experiments were made.

PART X.

Details of Post-mortem Examinations of cows from which Tubercular Meat and Organs were obtained for Experiments, with Details of Experiments on Animals.

PART X.

TABLE LXXVII.

COW 1.

Post-mortem Examination.—Cow killed at Metropolitan Slaughter-houses, Islington. As the carcase was cut up, a complete examination could not be made. Meat of a moderately good colour.

THORAX:
Pleura, Right.—Normal.
Do., Left.—Shows over one third of its surface thick masses of grapes, also in visceral pleura opposite this.
Lungs, Right.—Normal.
Lungs, Left.—(See pleura.) One caseating nodule in lung tissue, at surface, beneath grapes in lower lobe, 2½ inches by 1 inch.
Bronchial Glands.—Normal.
Pericardium.—Normal.

ABDOMEN:
Peritoneum.—Normal.
Lumbar Glands.—Normal.
Popliteal Glands.—Right, normal. Left, tubercular; shows one or two doubtful nodules.
Kidneys and Suprarenal Bodies.—Normal.

Meat.—Feeding Experiments.

Animals.	Part of Meat used and Amount and Duration of Feeding.	Killed or Died; No. of Days.	Post-mortem Examination and Remarks.
1 guinea-pig	1 kilo 500 grammes (3 lbs. 4½ ozs.) buttock plunged in boiling water 10 minutes; 3 feedings; 600 grammes (1 lb. 5 ozs.) collectively -	Killed 62	Nil.
1 do.		Killed 62	Nil.
1 do.		Killed 92	Nil.
1 do.		Killed 92	Nil.
1 do.		Killed 92	Nil.
1 do.		Killed 92	Nil.
6			
1 guinea-pig	2 kilos 380 grammes (5 lbs. 3 oz.) ribs, stripped, *i.e.*, grapes removed, boiled 1 hour; 3 feedings; 450 grammes (16 oz.) collectively - -	Killed 62	Nil.
1 do.		Killed 92	Nil.
1 do.		Killed 92	Nil.
1 do.		Killed 92	Nil.
1 do.		Killed 92	Nil.
1 do.		Killed 92	Nil.
6			
1 guinea-pig	Meat from ribs not stripped, *i.e.*, grapes left attached, boiled 1 hour; 3 feedings; 450 grammes (16 oz.) collectively - - -	Killed 62	Nil.
1 do.		Killed 62	Nil.
1 do.		Killed 92	Nil.
1 do.		Killed 92	Nil.
1 do.		Killed 92	Nil.
1 do.		Killed 92	Nil.
6			

Subcutaneous Inoculation and Intraperitoneal Injection Experiments.

Animals.	Killed or Died; No. of Days.	Post-mortem Examination and Remarks.
1 guinea-pig, subcutaneously (with piece of grapes, boiled ½ hour only).	Killed 61	Nil. Inoculation wound healed.
1 do. do.	Killed 70	Nil. do.
1 guinea-pig, intraperitoneally, with 2 cc. juice of do.	Killed 70	Nil.
1 do. do.	Killed 70	Nil.
4		

TABLE LXXVII.—*cont.*

Meat.—Feeding Experiments—*cont.*

Animals.	Part of Meat used and Amount and Duration of Feeding.	Killed or Died; No. of Days.	Post-mortem Examination and Remarks.
1 guinea-pig 1 do. 1 do. 1 do. 1 do. 1 do.	5½ kilos (12 lbs.), ribs stripped, *i.e.*, grapes removed, roasted 2 hours in gas stove; 3 feedings; 450 grammes (16 oz.) collectively - - -	Died 60 Killed 62 Killed 62 Killed 92 Killed 92 Killed 92	Nil. Nil. Nil. Nil. Nil. Nil.
6			
1 guinea-pig 1 do. 1 do.	Tubercular lung boiled 15 minutes; 1 feeding; 30 grammes (1 oz.) collectively -	Killed 61 Killed 70 Killed 70	Nil. Nil. Nil.
3			
1 guinea-pig **1 do.**	**Raw grapes from ribs (controls);** 1 feeding; 30 grammes (1 oz.) collectively -	Died 30 Killed 70	Nil. Nil.
2			

Subcutaneous Inoculation and Intraperitoneal Injection Experiments.—*cont.*

Animals.	Killed or Died; No. of Days.	Post-mortem Examination and Remarks.
1 guinea-pig (control) subcutaneously, with **juice of grapes.**	Killed 61	**Tubercular.** Extensively affected. Wound indurated, not healed; inguinal gland; glands in neck and under jaw on same side all tubercular; liver, spleen, mesenteric, and coeliac and lumbar glands, omentum, mediastinal (anterior and posterior), bronchial glands, and lung, all tubercular. Microscopic examination. Numerous tubercle bacilli found. The animal was photographed.
1 do. do.	Died 65	**Tubercular.** Very similar condition to above, but not so advanced in lungs. Tubercle bacilli found.
1 guinea-pig, injected intraperitoneally with 2 cc.	Died 52	**Tubercular.** Extensive tuberculosis. Tubercle near seat of inoculation, and scattered over peritoneal surface; spleen, liver, and mesenteric glands, intestines, all tubercular; tubercle nodule behind episternum, and in several of the intercostal spaces near the sternum in the diaphragm, mediastinal and bronchial glands, and lung. Microscopical examination. Tubercle bacilli found.
1 do. do.	Died 52	**Tubercular.** Extensive tuberculosis. Similar to above, but not so advanced in lung. Microscopic examination; numerous tubercle bacilli were found.
4		

TABLE LXXVIII.

COW 6.

The animal had been cut up before our arrival at the Metropolitan Cattle Market, Islington, so that a complete post-mortem examination could not be made.

The meat was darker than normal but the animal was well nourished.

Post-mortem Examination:

THORAX:

Costal Pleura.—Very well marked and extensive tubercular deposit between the ribs.

Lungs.—Not very much affected, except at the margins, where the tubercular deposit in the pleura had an appearance like that of the appendices epiploicæ.

Mediastinal Glands.—Some were slightly enlarged and showed commencing tubercle.

Pericardium.—Large amount of fat.

ABDOMEN:

Pelvic Glands.—Very early tubercle, only one or two affected.

Meat.—Feeding Experiments.

Animals.	Part of Meat used and Amount and Duration of Feeding.	Killed or Died; No. of Days.	Post-mortem Examination and Remarks.
1 guinea-pig	Rump plunged 10 minutes in boiling water; 6 feedings; 600 grammes (1 lb. 5 ozs.) collectively - - -	Killed 80	Nil.
1 do.		Killed 80	Nil.
1 do.		Killed 80	Nil.
1 do.		Killed 80	Nil.
4			
1 guinea-pig	Meat from ribs boiled [illegible] hour; 5 feedings; 600 grammes (1 lb. 5 ozs.) collectively -	Died 23	Too early to show.
1 do.		Killed 79	Nil.
1 do.		Killed 79	Nil.
1 do.		Killed 79	Nil.
4			
1 guinea-pig	Rump roasted 2½ hours in gas stove, 6 kilos; 5 feedings; 600 grammes (1 lb. 5 ozs.) collectively - -	Died 13	Too early to show.
1 do.		Killed 79	Nil.
1 do.		Killed 79	Nil.
1 do.		Killed 79	Nil.
4			
1 guinea-pig	**Raw rump (controls)**; 6 feedings; 600 grammes (1 lb. 5 ozs.) collectively -	Died 36	Nil.
1 do.		Killed 80	Nil.
1 do.		Killed 80	Nil.
1 do.		Killed 80	Nil.
4			
1 guinea-pig	**Raw meat from ribs (controls)**; 1 feeding about 500 grammes (1 lb. 1½ ozs.) -	Killed 80	Nil.
1 do.		Killed 80	Nil.
1 do.		Killed 80	Nil.
1 do.		Killed 80	Nil.
4			
1 cat	**Raw meat from ribs**; 4 feedings; 1,000 grammes (2 lbs. 3 ozs.) - -	Killed 46	Nil. Parasitic cysts in lungs.
1 kitten	**Do.** do.	Killed 46	Nil.

Subcutaneous Inoculation Experiments.

Animals.	Killed or Died; No. of Days.	Post-mortem Examination and Remarks.
1 guinea-pig - -	Killed 80	No tubercle; inoculation wound healed.
1 do. - - -	Killed 80	Do. do.
2		
1 guinea-pig (control).	Died 2	Too early to show tubercle.
1 do. do.	Died 2	Do. do.
2		
1 guinea-pig (control).	Died 50	**Tubercular.** Glands in groin enlarged and tubercular; glands behind sternum, especially the episternum, tubercular; lungs, liver, and glands at root and spleen all tubercular.
1 do. do.	Died 59	**Tubercular.** Extensively affected; tubercle at seat of inoculation; glands in groin enlarged and caseous; early tubercle of lung, but glands at root normal; advanced tubercle of liver and spleen, microscopic examination showed tubercular structure and great congestion, but no bacilli.
2		

TABLE LXXIX.

COW 9.

Animal obtained by authorities at the Royal Veterinary College, Camden Town. Was extremely emaciated. Had been kept under observation for some time. Ran down very rapidly towards the end, and was so weak that she could not stand, and had to be killed. A somewhat extensive swelling was observed on the right buttock, which was afterwards carefully examined.

Post-mortem Examination:

Subcutaneous tissue water-logged. *Muscles* flabby and dark in colour. In muscles of right buttock are numerous caseous areas or streaks, which appear to follow the lines of the intermuscular septa, and of the blood vessels. These are yellowish opaque, probably tubercular, but may be the result of a non-tubercular interstitial myositis (inflammation of the connective tissue of the muscles. On microscopic examination these were found to present the appearances described on p. 113, Part II. The mass in which these areas are well marked is about six inches broad and two inches deep. At a distance of three inches from the main mass there is not a trace of this mottling.

Udder and Glands.—Behind the udder the lymphatic glands are firm and nodular, but equally enlarged. On section they are found to be distinctly tubercular. All four quarters of the udder appear to be affected, the anterior pair the least so. Throughout the udder are small yellow caseous looking patches. The cow had not been giving milk for some time; some of these yellow patches are simply involuted gland tissue. All four ducts are much enlarged.

Thorax.—*Visceral pleura* covered with masses of tubercle, especially on the left side and on the lower portion of the right side. In the angle between the ribs and the diaphragm there is a solid mass of tubercle, and in "stripping" the chest wall it is necessary to remove the attachment of the diaphragmatic muscles in order to get rid of the whole of the tubercular material in this region. (Tubercle bacilli found in the "grapes" from the pleura.) The left lung is one mass of tubercle; other masses in both lungs, some caseous, others of comparatively recent development. Mediastinal glands tubercular.

Abdomen.—Tubercular vegetations seen on peritonal wall of stomach, in fact over whole of peritoneum, especially that covering the spleen, but the organ itself is unaffected. The omentum is also studded with tubercular nodules. The lumbar glands are tubercular.

Parts kept for microscopic examination. Udder, buttocks, and mixed muscle (buttock, intercostal muscles and muscles of abdominal wall used for feeding and inoculation purposes. Sections of lung and pleura were cut, and numerous tubercle bacilli were found.

Meat.—Feeding Experiments.

Animals.	Part of Meat used and Amount and Duration of Feeding.	Killed or Died; No. of Days.	Post-mortem Examination and Remarks.
1 guinea-pig	Rump plunged in boiling water 5 minutes; 5 feedings; 350 grammes (12¼ ozs.) collectively	Killed 66	Nil.
1 do.		Killed 167	Nil.
1 do.		Killed 171	Nil.
3			
	No raw control feedings -	—	
1 guinea-pig	Mixed muscle from intercostal, abdominal wall and buttock, plunged in boiling water 5 minutes; 8 feedings; 700 grammes (1 lb. 8½ ozs.) collectively - - -	Killed 66	Nil.
1 do.		Killed 213	Nil.
1 do.		Killed 213	Nil.
3			
1 guinea-pig	Tuberculous udder in small pieces, ½ inch thick, plunged in boiling water 5 minutes; 4 feedings; 500 grammes (1 lb. 1⅓ ozs.) collectively -	Killed 65	Nil.
1 do.		Killed 212	Nil. One white point in liver. Microscopic examination, fatty liver.
2			
	Raw meat - -	—	No feedings.

Subcutaneous Inoculation Experiments.

Animals.	Killed or Died; No. of Days.	Post-mortem Examination and Remarks.
1 guinea-pig - -	Died, 2	Too early to show tubercle.
1 guinea-pig (control).	Killed, 131	Nil. Inoculation wound healed.
1 guinea-pig - -	Died, 66	**Tubercular.** Dark-coloured scab at seat of inoculation; slight suppuration; glands of groin on same side considerably enlarged; radiating from inoculation point are numerous minute tubercles; glands in immediate neighbourhood distinctly enlarged and caseous; gland in groin on opposite side slightly enlarged and tubercular; chain of glands on each side of sternum, at junction with ribs, tubercular; tubercle of lung, bronchial and mediastinal glands, liver, coeliac glands, spleen, which is firmly adherent to diaphragm, glands in hilus of liver, mesenteric and mesocolic glands, and of lumbar and pelvic glands. Two or three tubercular ulcers in large and small intestines. Microscopic examination. Tubercle bacilli found in sections.
1 guinea-pig (control).	Killed, 68	**Tubercular.** Tubercle at seat of inoculation; gland in groin on side of inoculation enormously enlarged and tubercular; gland on other side unaffected; glands behind episternum and on each side of trachea or lower part of larynx, at root of lung, mediastinal glands; liver, spleen, mesenteric glands and glands in hilus of liver. Liver adherent to under surface of diaphragm, but no tubercle of diaphragm itself.

TABLE LXXX.

COW 11.

Post-mortem Examination.—Cow killed at Harrow.

THORAX:

Pleura and Pericardium.—Normal.

Lungs.—Both lower lobes affected throughout with miliary tubercles, some few points caseating. There was a calcified mass the size of a filbert in the upper part of the right lung. No grapes. Upper lobes quite healthy.

Heart and Peritoneum.—Normal.

ABDOMEN:

Liver.—Small tubercular nodule in the upper surface of the right lobe.

Spleen, Pancreas, Suprarenal Bodies.—Normal.

Kidneys.—No tubercle. In the right kidney, involving the cortex, was a small, round, firm, encapsuled tumour, like a uterine myoma.

Intestines and Mesenteric Glands.—Normal.

Udder, Uterus, and Ovaries.

All glands were quite normal, but somewhat softened. One of the bronchial glands, however, showed what might be a small deposit of tubercle.

Meat.—Feeding Experiments.

Animals.	Part of Meat used and Amount and Duration of Feeding.	Killed or Died; No. of Days.	Post-mortem Examination and Remarks.
1 guinea-pig	1 kilo 300 grammes (2 lbs. 13½ ozs.); muscle from shoulder, plunged in boiling water 10 minutes; 3 feedings; 500 grammes (1 lb. 1½ ozs.) collectively - - -	Killed 60	Nil.
1 do.		Killed 60	Nil.
1 do.		Killed 90	Nil.
1 do.		Killed 90	Nil.
1 do.		Killed 90	Nil.
1 do.		Killed 90	Nil.
6			
1 guinea-pig	1 kilo 800 grammes (3 lbs. 15 ozs.); rump, boiled 40 minutes; 3 feedings; 500 grammes (1 lb. 1½ ozs.) collectively - - - -	Killed 60	Nil.
1 do.		Killed 60	Nil.
1 do.		Killed 90	Nil.
1 do.		Killed 90	Nil.
1 do.		Killed 90	Nil.
1 do.		Killed 90	Nil.
6			
1 guinea-pig	1 kilo 800 grammes (3 lbs. 15 ozs.); ribs, boiled 1 hour; 3 feedings; 500 grammes (1 lb. 1½ ozs.) collectively -	Killed 60	Nil.
1 do.		Killed 60	Nil.
1 do.		Killed 90	Nil.
1 do.		Killed 90	Nil.
1 do.		Killed 90	Nil.
1 do.		Killed 90	Nil.
6			
1 guinea-pig	2 kilos 250 grammes (4 lbs. 15 ozs.); ribs roasted 1¼ hours in gas stove; 3 feedings; 300 grammes (10½ ozs.) collectively	Killed 60	Nil.
1 do.		Died 74	Nil.
1 do.		Killed 90	Nil.
1 do.		Killed 90	Nil.
4			

Subcutaneous Inoculation and Intraperitoneal Injection Experiments.

Animals.	Killed or Died; No. of Days.	Post-mortem Examination and Remarks.

TABLE LXXX.—*cont.*

Meat.—Feeding Experiments—*cont.*				Subcutaneous Inoculation and Intraperitoneal Injection Experiments—*cont.*		
Animals.	Part of Meat used and Amount and Duration of Feeding.	Killed or Died; No. of Days.	Post-mortem Examination and Remarks.	Animals.	Killed or Died; No. of Days.	Post-mortem Examination and Remarks.
1 guinea-pig 1 do. 1 do. 1 do. 1 do.	300 grammes ($10\frac{1}{2}$ ozs.); gland; boiled 30 minutes; 3 feedings; 300 grammes ($10\frac{1}{2}$ ozs.) collectively - - -	Killed 60 Killed 60 Killed 95 Killed 95 Killed 95	Nil. Nil. Nil. Nil. Nil. The gland which appeared enlarged we were only able to examine on cutting up after cooking, when no obvious signs of tubercle were manifest.	2 guinea-pigs; subcutaneously; piece of gland - - 2 guinea-pigs; intraperitoneally; 2 cc. emulsion of gland -	Killed 59 Killed 68 Killed 59 Killed 68	Nil; wound healed. Nil; do. Nil. Nil.
5 do.				4		
...	**Raw glands** - -	...	No feedings.	**2 guinea - pigs; subcutaneously; piece of raw gland (controls)** **2 guinea - pigs; intraperitoneally; with 2 cc. emulsion of raw gland - -**	Killed 59 Killed 68 Killed 59 Killed 68	Nil; wound healed. Nil; do. Nil. Nil. There was one grey point about the size of a pin-head in liver of the first of these two animals, which on microscopic examination was found to be localised interstitial hepatitis and fatty degeneration.
				4		
1 guinea-pig 1 do. 1 do. 1 do. 1 do. 1 do.	500 grammes (1 lb. $1\frac{1}{2}$ ozs.); lung, boiled 30 minutes; 3 feedings; 500 grammes (1 lb. $1\frac{1}{2}$ ozs.) collectively -	Killed 60 Killed 60 Killed 90 Killed 90 Killed 90 Killed 90	Nil. Nil. Nil. Nil. Nil. Nil. The portion of lung used in this experiment contained no obvious tubercle.	2 guinea-pigs; subcutaneously; piece of lung - - - 2 guinea-pigs; intraperitoneally; 2 cc. emulsion of lung -	Killed 59 Killed 68 Killed 59 Killed 68	Nil; wound healed. Nil; do. Nil. Nil.
6 do.				4		
...	**Raw lung** - - -	...	No feedings.	**2 guinea - pigs; subcutaneously; piece of raw lung - -** **2 guinea - pigs; intraperitoneally; 2 cc. emulsion of raw lung**	Killed 59 Killed 68 Killed 59 Killed 68	Nil; wound healed. Nil; do. Nil. Nil.
				4		

TABLE LXXXI.

COW 12.

Post-mortem Examination.—Cow killed at Harrow. Animal ill-nourished, very little subcutaneous or other fat.

THORAX:

Pleura.—Adhesion at both bases, more marked on right side.

Lungs.—Extensively tubercular and caseous.

Heart and Pericardium.—Normal.

Bronchial Glands.—Normal.

Postmediastinal Glands.—Two in the middle enlarged, one soft, other hard, showed no tubercle; other small one normal. One above fibroid and one next to it, above, extensively caseo-calcareous. Three others below similarly affected. Four out of eight tubercular.

ABDOMEN:

Peritoneum.—Normal.

Liver.—Shows three hydated cysts, each the size of a chestnut, on upper surface, also one on lower surface and one in the substance of left lobe. Two encapsuled yellow areas, about the size of a bean. Liver substance normal.

Spleen and Suprarenal Bodies.—Normal.

Kidneys.—Mottled on surface in parts, the whitish areas looking, on section, simply anæmic not caseous. Pale cortex, congested pyramids.

Pancreas.—Normal.

Lymphatic Glands.—Glands around stomach, pancreas, caecum and mesenteric glands and glands in hilus of liver, all normal.

Intestines.—No ulceration or tubercular deposit, a few submucous ecchymoses.

Uterus.—One horn contained a foetus a few weeks old.

Lumbar and Popliteal Glands.—Normal.

Udder.—Quite normal in sections in all quarters. Small tumour attached to base of left posterior teat, the size of a horse chestnut, white and tough on section, fibroma showing hyaline changes on microscopic examination.

Meat.—Feeding Experiments.

Animal.	Part of Meat used and Amount and Duration of Feeding.	Killed or Died; No. of Days.	Post-mortem Examination and Remarks.
1 guinea-pig 1 do. 1 do.	Foreleg plunged in boiling water 10 minutes; 3 feedings; 150 grammes (5ozs.) collectively	Died 8 Killed 86 Killed 86	Too early to show tubercle. Nil. Nil.
3			
1 guinea-pig 1 do. 1 do.	Foreleg boiled 30 minutes; 3 feedings; 150 grammes (5 ozs.) collectively - -	Died 8 Killed 86 Killed 86	Too early to show tubercle. Nil. Nil.
3			
1 guinea-pig 1 do. 1 do.	3 kilos (6 lbs. 9 ozs.) shoulder roasted 1 hour; 3 feedings; 200 grammes (7 ozs.) collectively -	Died 4 Died 72 Died 73	Too early to show tubercle. Nil. Nil.
3			
1 guinea-pig 1 do. 1 do.	4½ kilos (9 lbs. 13½ ozs.) shoulder roasted 2 hours; 3 feedings; 200 grammes (7 ozs.) collectively -	Died 8 Killed 86 Killed 86	Too early to show tubercle. Nil. Nil.
3			
1 guinea-pig 1 do. 1 do.	**Raw meat from foreleg controls;** 3 feedings; 150 grammes (5 ozs.) collectively -	Killed 86 Killed 86 Killed 86	Nil. Nil. Nil.
3			

Subcutaneous Inoculation Experiments.

Animal.	Killed or Died; No. of days.	Post-mortem Examination and Remarks.
1 guinea-pig 1 do. 1 do.	Killed 86 Killed 86 Killed 86	Nil. Nil. Nil.
3		

TABLE LXXXII.

COW 13.

Animal obtained for experimental purposes and kept at Harrow.

Post-mortem Examination.—Made half an hour after death. The animal was very thin. The little fat there was was of an orange yellow colour. Meat of good colour, and firm.

THORAX:

Pleura.—Normal. No excess of fluid.

Lungs.—Were affected with tubercle, miliary, and caseating. The posterior surfaces of the lower lobe were most affected, and section of the nodules showed caseation in the larger, and commencing caseation on the smaller ones. There was no pneumonic consolidation around the nodules: except for a parasitic cyst in the right lung, the rest of the lung tissue was normal.

Posterior Mediastinum.—The glands here showed hard miliary and caseous tubercle. The *bronchial* glands were matted together and caseous. The *anterior mediastinal* glands gave no evidence of the presence of tubercle.

Heart and Pericardium.—Normal.

ABDOMEN:

Peritoneum.—Quite normal, as were also the liver, spleen, udder, uterus (which contained a foetus), kidneys, vagina, and suprarenal bodies.

Small Intestine.—Quite normal. Mesenteric glands. One only of the glands slightly affected with tubercle.

Large Intestine.—At the lower part the gut appeared to be thinner than normal. There was a good deal of pigmentation, but no ulceration in any part of the intestinal tract. This was most marked in the lower part of the bowel.

Lumbar, Cœliac, Popliteal Glands, and Glands behind the Udder.—Normal.

Meat.—Feeding Experiments.

Animal.	Part of Meat used and Amount and Duration of Feeding.	Killed or Died; No. of days.	Post-mortem Examination and Remarks.
1 guinea-pig	1 kilo 300 grammes (2 lbs. 13⅓ ozs.) rump, boiled 50 minutes; 1 feeding; 170 grammes (6 ozs.) collectively	Killed 87	Nil.
1 do.		Killed 87	Nil.
1 do.		Killed 87	Nil.
3			
1 guinea-pig	2 kilo 600 grammes (5 lbs. 11 ozs.) rump, roasted 2 hours and 20 minutes; 1 feeding; 170 grammes (6 ozs.) collectively	Killed 87	Nil.
1 do.		Killed 87	Nil.
1 do.		Killed 87	Nil.
3			

TABLE LXXXIII.

COW 15.

Post-mortem Examination.—Cow killed at Harrow. The flesh of the carcase was of a fairly good colour.

THORAX:

Pleura.—Showed a few grapy vegetations along the lines of the ribs, chiefly in the middle of the thorax.

Lungs.—At the apex of every lobe in both lungs was a mass of tubercle, for the most part superficial, and as a rule not caseous. The patches were formed by an aggregation of miliary tubercles which here and there were beginning to become yellow and caseous.

Post Mediastinal glands.—Soft, not enlarged.

Anterior Mediastinal glands.—Normal, except one, which showed a few tubercle nobules.

Tracheal Glands.—Normal.

Bronchial Glands.—One showed miliary tubercles.

Cervical Glands.—Normal.

ABDOMEN:

Peritoneum.—Normal. No excess of fluid.

Spleen, Liver, Kidneys, Udder, Uterus, Vagina, Thyroid.—Normal.

Intestines and Cæcum.—Normal.

Mesenteric Glands.—A few were soft and showed some minute hæmorrhages into their substance. No tubercle.

Iliac Glands.—Normal.

Lymphatics near Udder.—Normal.

Meat.—Feeding Experiments.

Animals.	Part of Meat used, and Amount and Duration of Feeding.	Killed or Died; No. of Days.	Post-mortem Examination and Remarks.
1 guinea-pig	Muscle plunged in boiling water 10 minutes; 4 feedings; 600 grammes (1 lb. 5 ozs.) collectively - - -	Died 8	Too early to show tubercle.
1 do.		Killed 49	Nil.
1 do.		Killed 53	Nil.
1 do.		Killed 53	Nil.
1 do.		Killed 88	Nil.
1 do.		Killed 88	Nil.
6			
1 guinea-pig	1 kilo (2 lbs. 3 ozs.); muscle from rump boiled 40 minutes; 4 feedings; 600 grammes (1 lb. 5 ozs.) collectively -	Died 8	Too early to show.
1 do.		Killed 88	Nil.
1 do.		Killed 66	Nil.
1 do.		Killed 66	Nil.
1 do.		Killed 88	Nil.
1 do.		Killed 88	Nil.
6			
1 guinea-pig	$4\frac{1}{2}$ kilos (9 lbs. $13\frac{1}{2}$ ozs.); buttock roasted $2\frac{1}{2}$ hours; 4 feedings; 600 grammes (1 lb. 5 ozs.) collectively -	Died 2	Too early to show tubercle. Venous congestion of large intestine and cæcum; solitary glands and peyers patches enlarged and œdematous, small hæmorrhages into their substance; in these glands in small intestine are white opaque points, in some cases these being scattered over whole glandular patch; mesenteric glands slightly enlarged; liver surface mottled over with small yellowish patches, very irregular in distribution; lungs, two yellowish grey points; spleen, normal; mediastinal gland evidently enlarged. Photograph made of intestine and cæcum (*see* Fig. 15, Plate VII.). This condition important, as it may so readily be taken for tuberculosis.

Subcutaneous Inoculation Experiments.

Animals.	Killed or died; No. of Days.	Post-mortem Examination and Remarks.
1 guinea-pig - -	Died 7 -	Too early to show; most of the organs eaten by other guinea-pig in cage.
1 do. - -	Died 9 -	Too early to show; inoculation wound healed.
2		
1 guinea-pig - -	Died 3 -	Too early to show; marked inflammation evidently set up by inoculation.
1 do. - -	Killed 49 -	Nil; inoculation wound healed.
2		
1 guinea-pig - -	Killed 49 -	Nil; inoculation wound had not quite healed. Spleen nodular, otherwise animal was perfectly normal. Microscopic examination of spleen revealed infarction.
1 do. - -	Killed 52 -	Nil; inoculation wound healed.
2		

TABLE LXXXIII.—*cont.*

Meat.—Feeding Experiments—*cont.*				Subcutaneous Inoculation Experiments—*cont.*		
Animals.	Part of Meat used, and Amount and Duration of Feeding.	Killed or died; No. of Days.	Post-mortem Examination and Remarks.	Animals.	Killed or died; No. of Days.	Post-mortem Examination and Remarks.
1 guinea-pig	4½ kilos (9 lbs. 13½ ozs.); buttock roasted 2½ hours; 4 feedings; 600 grammes (1 lb. 5 ozs.) collectively	Died 8	Too early to show.			
1 do.		Killed 66	Nil.			
1 do.		Killed 66	Nil.			
1 do.		Killed 88	Nil.			
1 do.		Killed 88	Nil.			
5						
1 guinea-pig	**Raw muscle from various parts (controls);** 4 feedings; 600 grammes (1 lb. 5 ozs.) collectively	Died 35	Nil.	**1 guinea-pig**	Died 5	Too early to show; inoculation wound not healed.
1 do.		Killed 66	Nil.	**1 do.**	Died 8	Do. do.
1 do.		Killed 66	Nil.	**2**		
1 do.		Killed 66	Nil.			
1 do.		Killed 88	Nil.			
1 do.		Killed 88	Nil.			
6						
1 guinea-pig	**Raw meat from ribs;** 4 feedings; 600 grammes (1 lb. 5 ozs.) collectively	Killed 60	Nil.	**1 guinea-pig**	Killed 49	Nil. Inoculation wound quite healed. Spleen presented nodular appearance. Other organs absolutely normal. Microscopic examination of spleen showed infarction.
1 do.		Killed 60	Nil.			
1 do.		Killed 60	Nil.			
1 do.		Killed 60	Nil.	**1 do.**	Killed 52	Nil. Inoculation wound healed.
1 do.		Killed 60	Nil.	**2**		
1 do.		Killed 60	Nil.			
6						
1 guinea-pig	1 kilo (2 lbs. 3 ozs.); tubercular lung boiled 40 minutes; 4 feedings; 600 grammes (1 lb. 5 ozs.) collectively	Died 6	Too early to show tubercle. Fatty degeneration of liver.	1 guinea-p	Killed 49	Nil. Inoculation wound healed.
1 do.		Died 8	Too early to show tubercle.	1 do.	Killed 52	Nil. do.
1 do.		Killed 66	Nil. Spleen after passing through spirit looked suspicious. Microscopic examination showed no evidence of tubercle, but only enlarged malpighian bodies and some rod-shaped organisms.	2		
1 do.		Killed 66				
1 do.		Killed 88				
1 do.		Killed 88				
6						

TABLE LXXXIV.

COW 16.

Cow killed at Harrow. Animal very emaciated. Meat was of good colour, but soft and boggy.

Post-mortem Examination:

THORAX:

Pleura.—Normal.

Lungs.—The lower half of the left lobe was one mass of tubercle, which was firm at the edges and breaking down in the centre. There were several other masses in the lungs about the size of a fist, notably, one, larger than the others, in the right lower lobe at the apex. There were also one or two patches of miliary tubercles. The pleura was not thickened or involved in any way. The right lung contained two parasitic cysts.

Lymphatic Glands.—Bronchial, posterior, mediastinal, and those behind sternum all caseating. Other glands normal.

Heart, Larynx, and Trachea.—Normal.

ABDOMEN:

Liver.—Contained a small parasitic cyst. Showed one small white spot on its upper surface, probably not a tubercle.

Peritoneum, Spleen, and Kidneys.—Normal.

Intestines.—There were several small tubercles distributed throughout these, for the most part in the ileum. The larger nodules, some nearly as large as a pea, were all cretaceous. A tapeworm was found in the intestines.

Ovaries, Uterus, Udder.—Normal.

Feeding Experiments.

Animals.	Part of Meat used, and Amount and Duration of Feeding.	Killed or Died; No. of Days.	Post-mortem Examination and Remarks.
1 guinea-pig	Buttock plunged in boiling water 10 minutes; 4 feedings; 800 grammes (1 lb. 12 ozs.) collectively - -	Died 21	Too early to show tubercle.
1 do.		Killed 88	Nil.
1 do.		Killed 88	Nil.
1 do.		Killed 88	Nil.
1 do.		Killed 92	Nil.
1 do.		Killed 92	Nil.
6			
1 guinea-pig	3 kilos buttock boiled 1 hour; 4 feedings; 800 grammes (1 lb. 12 ozs.) collectively -	Killed 88	Nil. Intestinal glands appeared prominent. Microscopic examination showed no evidence of tubercle.
1 do.		Killed 88	Nil.
1 do.		Killed 88	Nil. Intestinal glands appeared prominent. Microscopic examination showed only normal structure.
1 do.		Killed 88	Nil.
1 do.		Killed 88	Nil.
1 do.		Killed 88	Nil.
6			
1 guinea-pig	2 kilos lung boiled 1 hour; 4 feedings; 600 grammes (1 lb. 12 ozs.) collectively -	Died 1	Too early to show tubercle.
1 do.		Killed 87	Nil.
1 do.		Killed 87	Nil. Nodule in liver evidently parasitic.
1 do.		Killed 87	Nil.
1 do.		Killed 92	Nil.
1 do.		Killed 92	Nil.
6			

Subcutaneous Inoculation Experiments.

Animals.	Killed or Died; No. of Days.	Post-mortem Examination and Remarks.
1 guinea-pig - -	Killed 85 -	Nil. Inoculation wound healed.
1 guinea-pig - -	Killed 85 -	Nil. Inoculation wound healed.
1 guinea-pig - -	Killed 85	Nil. Inoculation wound healed.

TABLE LXXXIV.—*cont.*

Feeding Experiments—*cont.*

Animals.	Part of Meat used and Amount and Duration of Feeding.	Killed or Died; No. of Days.	Post-mortem Examination and Remarks.
1 guinea-pig	**Raw tuberculous lung controls.** 2 feedings; 300 grammes ($10\frac{1}{2}$ ozs.) collectively - -	Died 7	Too early to show tubercle. The peritoneal cavity was full of a watery-like fluid.
1 do.		Killed 25	**Tubercular.** Very early tubercle in intestine.
1 do.		Killed 35	**Tubercular.** Two glands in intestine slightly enlarged, as were also those in cæcum; liver and spleen tubercular. Lungs; several gelatinous patches not tubercular. Part of intestine and cæcum photographed. Fig. II., Plate VI.
1 do.		Killed 92	Nil.
1 do.		Killed 92	**Tubercular.** Mesenteric glands not markedly affected. Liver and lung tubercular. Spleen normal.
1 do.		Killed 92	Nil.
6			

Subcutaneous Inoculation Experiments—*cont.*

Animals.	Killed or Died; No. of Days.	Post-mortem Examination and Remarks.
1 guinea-pig control	Killed 85 -	Nil. Inoculation wound healed. The portion of lung used in this inoculation was not tubercular to the naked eye.

TABLE LXXXV.

COW 19.

Cow procured by authorities of the Royal Veterinary College, Camden Town. In poor condition. Milk had been given up to time of slaughter. This milk somewhat yellow, otherwise normal. Sent to Islington to be slaughtered.

Post-mortem Examination:

Udder and Glands.—Udder small, but still contained milk; the glands behind the udder enlarged *but equal in size* and presented no naked eye evidence of tuberculosis.

Thorax.—In both lungs large caseous areas, from size of a fist down to that of a hazel nut, are seen. One portion of lung is pneumonic (in a condition of inflammation). In the bronchi are caseous plugs, and around these plugged bronchi are areas or zones of tubercle in various stages of development. The glands at the root of the lung (mediastinal glands) are distinctly tubercular.

Abdomen.—A few tubercular glands are seen behind the diaphragm, otherwise no trace of tuberculosis in this cavity.

Parts kept for microscopic examination. Bacilli found in tubercular parts.

Muscle of buttock kept for feeding. No tubercle to be seen in this, but Dr. Martin found some interstitial myositis and interfibrillar hæmorrhages in a piece of muscle kept by him.

Meat.—Feeding Experiments.

Animals.	Part of Meat used and Amount and Duration of Feeding.	Killed or Died; No. of Days.	Post-mortem Examination and Remarks.
1 guinea-pig	Rump plunged in boiling water 5 minutes; 8 feedings; 750 grammes (1 lb. 10 ozs.) collectively - - -	Killed 6	Nil.
1 do.		Killed 167	Nil.
1 do.		Killed 171	Nil.
3			

Subcutaneous Inoculation Experiments.

Animals.	Killed or Died; No. of Days.	Post-mortem Examination and Remarks.

TABLE LXXXV.—*cont.*

Meat.—Feeding Experiments—*cont.*

Animals.	Part of Meat used and Amount and Duration of Feeding.	Killed or Died; No. of Days.	Post-mortem Examination and Remarks.
1 guinea-pig	½ kilo tuberculous lung plunged in boiling water 5 minutes; 6 feedings; 250 grammes (9 ozs.) collectively	Killed 67	Nil.
1 do.		Died 80	**Tubercular.** Lung highly tubercular. Tubercle bacilli numerous. No other organs examined, as they had been eaten by animal in cage.
1 do.		Killed 168	Nil.
3			

Subcutaneous Inoculation Experiments—*cont.*

Animals.	Killed or Died; No. of Days.	Post-mortem Examination and Remarks.
1 guinea-pig	Killed 140	Nil. Inoculation wound healed. The portion of lung used in this inoculation was not tubercular to the naked eye.
1 do.	Killed 69	**Tubercular.** The wound had opened up, and underneath the dry scar was a quantity of yellow pus. Small tubercle nodules seen around the point of inoculation; gland in groin on same side enormously enlarged and filled with soft cheesy pus; gland on the other side not affected; glands in left axilla enlarged and tubercular, especially in the cortex; post mediastinal, episternal, bronchial, coeliac, lumbar, and pelvic glands, and glands at hilus of liver all tubercular; liver, spleen, and upper part of small intestine tubercular.
2		

TABLE LXXXVI.

COW 20.

Post-mortem Examination.—Cow killed at Harrow.

THORAX:

Pleura.—A few clusters of grapes at the lower part with some ecchymoses.

Lungs.—There were numerous large scattered patches of yellow tubercle with some areas of softening.

Bronchial Glands.—Very large. Old calcareo-caseous deposit and recent tubercle.

Pericardium and Heart.—Normal.

ABDOMEN:

Liver and Spleen.—There was some miliary tubercle on the peritoneal covering, but the substance was normal.

Intestines.—*Ileum* showed a tubercular ulcer and a deposit of tubercle in the mucous membrane. The rest of the gut was not examined.

Coeliac Glands.—Recent tubercle.

Mesenteric Glands.—Enormously enlarged. Old and recent tubercle.

Lumbar Glands.—Enlarged and tubercular.

Popliteal Glands.—Slightly enlarged. Miliary tubercle in cortex.

Udder.—The posterior quarters were greatly enlarged, and together formed one mass of tough grey yellow tubercle. The anterior quarters were normal in some parts, others were infiltrated with tubercle. There were no abscesses. The sinuses contained a somewhat turbid serous fluid, in which tubercle bacilli were found.

Meat.—Feeding Experiments.

Animals.	Part of Meat used and Amount and Duration of Feeding.	Killed or Died; No. of Days.	Post-mortem Examination and Remarks.
1 guinea-pig	Mixed meat from buttock intercostal muscles and abdominal wall boiled in steam sterilizer 45 minutes; 2 feedings; 400 grammes (14 ozs.) collectively	Died 141	Nil. The animals that died in this series succumbed apparently to the intense cold which was experienced during December 1891 and January 1892.
1 do.		Killed 168	Nil.
1 do.		Killed 169	Nil.
1 do.		Died 142	Nil.
1 do.		Killed 168	Nil.
1 do.		Killed 168	Nil.
1 do.		Died 121	Nil.
1 do.		Died 121	Nil.
8			
1 guinea-pig	**Raw meat (controls)**; 3 feedings; 300 grammes (10½ ozs.) collectively	Killed 168	Nil.
1 do.		Died 17 days	Too early to show tubercle. One doubtful nodule situated between two of the ribs was cut. Microscopic examination; structure not tubercular, no tubercle bacilli.
1 do.		Killed 169	Nil.
1 do.		Killed 169	Nil.
4			

TABLE LXXXVII.

COW 21.

Cow sent from Denmark by Professor Bang. This animal was in moderately good condition when she arrived, and was giving four to five quarts a day of somewhat "thin" milk. She took food well. All the physical signs of tuberculosis of the lung were present. The udder was enormously enlarged, especially the left anterior quarter. The glands behind and in front of the udder were enormously enlarged, especially that on the left side. This enlargement gradually increased, the glands and udder became harder and more nodular, the animal's condition rapidly fell off, and ultimately she had to be killed, as her breathing became more and more distressed.

Post-mortem Examination :

Muscles very flaccid and watery, dark in colour, evidently much wasting.

Thorax.—Well marked pleurisy, evidently of tubercular origin. Lungs studded with large tubercular patches. Glands around bronchus very much enlarged and caseous, as were also the mediastinal glands.

Abdomen.—*Stomach, Liver, Spleen, Pancrea,* and *Kidneys* all normal.
Well marked tubercular peritonitis, especially on the under surface of the diaphragm. Here there was also a more acute process going on, evidenced by the small hæmorrhages.

Mesentery.—Near its attachment to the intestine the mesentery is enormously thickened, and contains between its folds large masses of distinctly caseous tubercular glands, which on miscroscopic examination were found to contain tubercle bacilli in large numbers.

Intestines.—Large and small. Mucous membrane very much congested. A series of small tubercular ulcers with thickened red margins and rough yellow flaws throughout the whole of the large intestine and the lower two-thirds of the small intestine.

Cœcum.—Here are a number of similar tubercular ulcers, and just at the valve there is a large thickened tubercular patch, apparently an enlarged gland.

The Udder is distinctly tubercular. Near the left posterior quarter is a series of large cavities containing serous fluid. These are lined with soft caseous material, and have assumed the position of large reservoirs. This quarter of the udder is enormously enlarged and distinctly caseous, is extremely hard, and has very little normal structure left, the large tubercular masses in it being in various stages of growth. The gland behind this quarter is about 6 inches long and 2½ inches broad, and is caseous throughout its whole extent. The corresponding quarter on the right side is also apparently tubercular, and the gland, though not so much enlarged as that on the left side, is much enlarged and caseous. The left and anterior quarter is distinctly tubercular, but the right anterior quarter is not markedly affected, though there appear to be one or two recent nodules even here.

Uterus.—Is very much congested. Here and there are small pale patches, which apparently occupy the positions of the cotyledons, and are probably tubercular.

The *Lumbar* glands and those around the uterus are enormously enlarged and distinctly caseous.

Parts kept.—Buttock and lung, both for feeding and inoculating purposes. On section numerous tubercle bacilli found in udder, left posterior, left anterior, and right posterior quarters, and mesenteric glands.

Feeding Experiments.

Animals.	Part of Meat used and Amount and Duration of Feeding.	Killed or Died; No. of Days.	Post-mortem Examination and Remarks.
1 pig - - - - -	3 kilos (6 lbs. 9 ozs.) rump roasted $1\frac{1}{2}$ hours in gas stove; 680 grammes (1 lb. 8 ozs.) in 2 feedings.	Killed 72 - - -	Nil.
1 pig - - - - -	$2\frac{1}{2}$ kilos (5 lbs. $7\frac{1}{2}$ lbs.) tuberculous lung boiled 50 minutes; 600 grammes (1 lb. 5 ozs.); 1 feeding.	Killed 70 - -	**Tubercular.** No tubercle in pharynx or tonsils; sub-maxillary and parotid glands enormously enlarged; in the liver and spleen a few tubercle nodules; mesenteric, mesocolic, and coeliac glands tubercular; lungs, early tubercle in right, older in left; bronchial glands enlarged, but not tubercular; a few tubercular nodules on under surface of diaphragm; thoracic duct distended, walls apparently tubercular. Disease, though diffused, is progressing very slowly.

TABLE LXXXVII.—*cont.*

Feeding Experiments—*cont.*

Animals.	Part of Meat used and Amount and Duration of Feeding.	Killed or Died; No. of Days.	Post-mortem Examination and Remarks.
1 guinea-pig	Tubercular lung boiled 50 minutes; 2 feedings; 300 grammes (10½ ozs.) collectively	Died 16	Too early to show tubercle.
1 do.		Killed 73	**Tubercular.** Spleen, liver, and lungs all tubercular; intestines not affected. Microscopic examination tubercle bacilli found.
1 do.		Killed 73	Nil.
1 do.		Killed 73	Nil.
1 do.		Killed 73	**Tubercular.** Lung tubercular. Microscopic examination; tubercle bacilli found. This apparently acquired by inhalation from food trough while feeding.
1 do.		Killed 73	Nil.
6			
1 pig	**Raw tuberculous lung control;** 750 grammes (1 lb. 10 ozs.); 1 feeding.	Died 64	**Tubercular.** Well marked and extensive tuberculosis. No tubercle of the pharynx or ulceration of the tonsils, a small tubercle nodule found in the substance of one tonsil; glands in neck near parotid and submaxillary glands, forming a regular chain, caseous and enlarged; intestine not tubercular, but much congested; mesenteric and coeliac glands tubercular. Glands at hilus of liver, liver, and spleen all tubercular. The liver is covered with a "shower" of minute tubercle points; diaphragm and left costal pleura, post-sternal glands, bronchial and mediastinal glands all tubercular; lungs adherent to wall of chest, but no tubercle in their substance.
1 guinea-pig	**Raw tuberculous lung control;** 1 feeding. 600 grammes (1 lb. 5 ozs.) collectively.	Died 73	**Tubercular.** Extensive tuberculosis. Tubercle of intestines and mesenteric glands, liver, spleen, post-sternal glands and lungs.
1 do.	**Do.** 4 feedings	Killed 37	**Tubercular.** Extensively affected. Tubercle of intestine, cæcum, liver, spleen, mesenteric, coeliac and lumbar glands, of glands in neck, and early tubercle of lung; bronchial and mediastinal glands normal. Microscopic examination; tubercle bacilli found.
1 do.	**Do.** 4 do.	Died 48	**Tubercular.** Similar to above, but, in addition, bronchial glands affected. Tubercle bacilli found.
1 do.	**Do.** 1 do.	Died 52	**Tubercular.** Extensively affected. Similar to above, but, in addition, under surface of diaphragm, parietal peritoneum, and omentum are all tubercular. Microscopic examination; tubercle bacilli found.
1 do.	**Do.** 1 do.	Died 124	**Tubercular.** Advanced stage. Similar to above, and, in addition, peritoneal covering of kidney affected.
5			
6 do.	**Raw tuberculous glands;** 1 feeding; 150 grammes	Killed between 25 and 59 days	**All Tubercular.** Morbid processes similar to those obtained in above series of feeding experiments, where raw lung was used. Microscopic examination, tubercle bacilli found in two cases, examined as samples, out of the six.

TABLE LXXXVIII.

COW 22.

Post-mortem Examination.—This animal was killed at Harrow, where Dr. Martin had been using its milk for experimental purposes.

Animal much emaciated. *Thyroid Gland* normal and no tubercle in cervical glands.

THORAX:

Grapes.—On both visceral and parietal pleuræ on both sides, most numerous and of largest size at the bases of the *lungs*, of which the greater part of both lower lobes consisted of caseous matter breaking down in the centre. The apices of the other lobes were the parts most affected, but very little of the tissue in any part of the lungs was free from miliary tubercles.

The anterior and posterior Mediastinal and Bronchial Glands are all enormously enlarged, some of them as large as an average sized human kidney, caseous almost throughout, and, with one or two exceptions, calcifying.

TABLE LXXXVIII.—*cont.*

COW 22—*cont.*

ABDOMEN:

Peritoneum.—No excess of fluid, but surface somewhat slimy to the touch. Attached to the peritoneum, at the rim of the true pelvis, are numerous small "grapes" a few were also attached to the peritoneum and the pouch of Douglas, and also on the utero-vesical ligament some few large "grapes" were met with, lying on the under surface of the central tendon of the diaphragm and attached to the crura; a number of smaller ones were found on the peritoneum covering the anterior surface of the stomach, and on outer surface of spleen and lateral and anterior surface of liver. These organs otherwise normal.

Kidneys.—Both much enlarged and contain numerous miliary tubercles commencing to caseate. These were limited to the cortex and were most numerous at either extremity.

Intestines.—The small intestine contained tubercles in all stages of caseation, ulcerating and calcifying. They are most numerous in Peyers patches.

The cæcum.—Is the seat of a few tubercular ulcers and there was some slight deposit of tubercle in the large intestine.

Mesenteric glands.—All affected with tubercle to a greater or less extent. Some few are reddened, softened, and becoming caseous, but the great majority showed very little glandular structure and were beginning to calcify.

Glands around the Pylorus.—Show commencing tubercle; coeliac glands enlarged, softened, and infiltrated with tubercle; iliac and lumbar glands show early tubercle on the right side. No tubercle in gland at hilus of liver.

Udder, Vagina, and Ovaries normal.

Feeding Experiments.

Animals.	Part of Meat used and Amount and Duration of Feeding.	Killed or Died; No. of Days.	Post-mortem Examination and Remarks.
1 guinea-pig	Buttock plunged in boiling water 10 minutes; 4 feedings; 500 grammes (1 lb. 1½ ozs.) collectively	Died 2	Too early to show tubercle. Intestinal glands showed opaque spots similar to those observed in guinea-pig fed on roasted buttock of Cow 15. Intestine photographed.
1 do.		Killed 48	Nil.
1 do.		Killed 48	Nil.
1 do.		Killed 48	Nil.
1 do.		Killed 48	Nil. Liver, fatty degeneration.
1 do.		Killed 48	Nil.
6			
1 guinea-pig	Ribs, boiled 40 minutes; 4 feedings; 510 grammes (1 lb. 2 oz.) collectively	Killed 83	Nil. Small suppurating point in mesenteric gland, but no tubercle bacilli could be demonstrated on microscopic examination.
1 do.		Killed 83	Nil.
1 do.		Killed 83	Nil.
1 do.		Killed 83	Nil.
1 do.		Killed 83	Nil.
5			
1 guinea-pig	Ribs, with pleura attached, roasted 1¼ hours in gas stove; 4 feedings; 500 grammes (1 lb. 1½ ozs.) collectively	Died 7	Too early to show tubercle. Spleen, several yellowish white points; microscopic examination; no tubercle bacilli
1 do.		Died 7	Too early to show tubercle.
1 do.		Killed 48	Nil.
1 do.		Killed 48	Nil.
1 do.		Killed 48	Nil.
1 do.		Killed 48	Nil. Liver fatty.
6			

TABLE LXXXVIII.—*cont.*

Feeding Experiments—*cont.*

Animals.	Part of Meat used and Amount and Duration of Feeding.	Killed or Died ; No. of Days.	Post-mortem Examination and Remarks.
1 guinea-pig	**Raw buttock,** in 4 feedings ; 300 grammes (10½ ozs.) ; 4 feedings	Killed 83	Nil.
1 do.		Killed 83	Nil.
1 do.		Killed 83	Nil.
1 do.		Killed 83	Nil.
1 do.		Killed 83	Nil.
1 do.		Killed 83	Nil.
6			
1 guinea-pig	1 kilo 500 grammes (3 lbs. 4½ oz.) tuberculous lung boiled 1 hour ; 4 feedings ; 500 grammes (1 lb. 1½ ozs.) collectively	Killed 48	Nil.
1 do.		Killed 48	Nil.
1 do.		Killed 48	Nil.
1 do.		Killed 48	Nil.
1 do.		Killed 48	Nil.
1 do.		Killed 48	Nil.
6			
1 guinea-pig	**Raw tuberculous lung (controls)** ; 4 feedings ; 500 grammes (1 lb. 1½ ozs.) collectively	Died 4	Too early to show tubercle.
1 do.		Killed 48	**Tubercular.** Ulceration of both intestine and cæcum ; coeliac and mesenteric glands, lung and bronchial and mediastinal gland, all tubercular. Microscopic examination ; tubercle bacilli found.
1 do.		Killed 48	**Tubercular.** Same condition as above, but in addition the glands in the neck under the jaw and behind the sternum also tubercular. Microscopic examination ; tubercle bacilli found.
1 do.		Killed 48	**Tubercular.** do. do.
1 do.		Killed 48	**Tubercular.** do. do.
1 do.		Killed 48	**Tubercular.** Very early tuberculosis. A single enlarged gland in intestine ; mesenteric gland slightly enlarged ; spleen contained a couple of small tubercle nodules.
6			
1 guinea-pig	470 grammes ; tuberculous glands roasted 1 hour in gas stove ; 4 feedings ; 470 grammes (16½ ozs.) collectively	Died 7	Too early to show tubercle.
1 do.		Died 15	Do. do.
1 do.		Killed 83	**Tubercular.** Mesenteric glands distinctly enlarged and hard ; intestines normal ; spleen was suspicious-looking, and there were several opaque points in lung. On microscopic examination of mesenteric glands, tubercle bacilli were found.
1 do.		Killed 83	**Tubercular.** Mesenteric glands only affected.
1 do.		Killed 83	**Tubercular.** do. do.
1 do.		Killed 83	Nil.
6			
1 guinea-pig	**Raw tuberculous glands (controls)** ; 4 feedings ; 190 grammes (6¾ ozs.) collectively	Died 7	Too early to show tubercle. Necrotic spleen.
1 do.		Died 15	Do. do.
1 do.		Died 21	Nil.
1 do.		Died 97	**Tubercular** throughout the body.
1 do.		Died 127	**Tubercular.** Advanced stage. Every organ and gland tubercular ; animal photographed and cast made.
1 do.		Killed 140	Nil.
6			

TABLE LXXXIX.

COW 23.

The milk of this animal whilst alive had been used for experimental purposes by Dr. Martin. She was extremely emaciated and in bad condition generally. Killed at Harrow.

Post-mortem Examination.—Very little fat. Carcase very wet. Meat very dark in colour. Some parts of rump pale and moist. No evident tubercle.

THORAX:

Pleura.—Bright and soft; visceral and parietal layers all covered with "grapes."

Lungs.—Right lung. Upper lobe infiltrated with gritty tubercle, caseous in parts, the outer part of the lower lobe is comparatively healthy, with a few outlying nodules of caseous tubercle. The inner border and surface of the lower lobe are in an advanced fibrous condition, with gritty nodules of tubercle between.

Left lung. At apex a tubercular abscess containing thick pus. The remainder of the upper lobe is infiltrated with hard gritty tubercle. In the lower lobe there is much the same distribution of fibrous and gritty tubercle, as in the left lung; healthy lung, and outlying nodules of hard caseous tubercle, but in addition there is a small abscess cavity in the upper part of the lower lobe.

Glands.—Behind the sternum are enlarged glands containing hard gritty and caseous tubercle. Posterior, mediastinal and bronchial glands greatly enlarged and infiltrated with similar masses of tubercle. One small gland on surface of left infraspinatus muscle caseous in centre, tubercular.

Heart and Pericardium.—Normal.

ABDOMEN:

Peritoneum.—Left parietal layer covered with thick masses of "grapes." Right half not so much affected, but also studded with "grapes." The under surface of the diaphragm is thickly covered with grapes, and there were numerous tubercles in the mesentery and on the great omentum. Pelvic peritoneum covered with grapes and pelvic organs matted together.

Liver.—Adhesions on surface (covered with grapes). Substance dark and glistening. Evident tubercle standing out from this. Small cyst with clear contents on under surface. At one part of under surface are three yellow areas (½ in. in diameter), which on section are seen to pass for some distance into the liver substance. A larger mass of similar nature. Not evidently tubercular. No caseation.

Spleen.—Nodules on surface. Malpighian corpuscles enlarged.

Kidneys.—Five or six areas (½ in. in diameter) on surface. Whitish gelatinous looking. Some times nodular. Wedge shaped in section. These are tubercular.

Suprarenal Bodies.—Normal.

Intestines.—One nodule about ⅓ in. in diameter, projecting from the mucous membrane of the ilium at about its middle.

Glands around stomach and in hilus of liver not affected. Mesenteric glands affected with tubercle, some showed several areas of hard, gritty, or caseous tubercle, others only a speck.

Lumbar and Popliteal Glands.—Normal.

Uterus.—Embedded in tubercular mass. No evident tubercle of mucous membrane or of the cotyledons.

Udder.—Quite normal, as are the glands behind it.

Meat.—Feeding Experiments.

Animal.	Part of Meat used and Amount and Duration of Feeding.	Killed or Died; No. of Days.	Post-mortem Examination and Remarks.
1 guinea-pig	5 kilos 800 grammes (12 lbs. 11 ozs.) plunged in boiling water 10 minutes; 3 feedings; 300 grammes (10½ ozs.) collectively - - -	Died 13	Too early to show.
1 do.		Killed 123	Nil.
1 do.		Died 117	Nil.
3			
1 guinea-pig	6 kilos (13 lbs. 2 ozs.) meat from rump roasted 3 hours; 3 feedings; 300 grammes (10½ ozs.) collectively - -	Died 103	Nil.
1 do.		Killed 123	Nil.
1 do		Killed 123	Nil.
3			

Subcutaneous Inoculation Experiments.

Animal.	Killed or Died; No. of Days.	Post-mortem Examination and Remarks.
1 guinea-pig - -	Died 5	Too early to show tubercle.
1 do. - -	Killed 123	Nil. Wound healed.
1 do - - -	Killed 123	Nil. do.
3		
1 guinea-pig - -	Died 23	Nil. Wound healed.
1 do. - -	Died 74	Nil. do.
1 do. . -	Killed 123	Nil. do.
3		

TABLE LXXXIX.—*cont.*

Meat.—Feeding Experiments—*cont.*

Animals.	Part of Meat used and Amount and Duration of Feeding.	Killed or Died; No. of Days.	Post-mortem Examination and Remarks.
1 guinea-pig	**Raw meat (controls)**; 3 feedings; 300 grammes ($10\frac{1}{2}$ ozs.) collectively - -	Died 122	Nil.
1 do.		Killed 123	Nil. Spleen. One very large nodule extending over whole end. On microscopic examination no evidence of tubercle could be discovered; there were, however, necrotic areas with diplococci and rod-shaped organisms present.
1 do.		Killed 123	Nil.
3			
1 cat	$1\frac{1}{4}$ kilos (2 lbs. 12 ozs.) tubercular lung roasted, $2\frac{1}{4}$ hours. 300 grammes ($10\frac{1}{2}$ ozs.)	Killed 123	Nil.

Subcutaneous Inoculation Experiments—*cont.*

Animals.	Killed or Died; No. of Days.	Post-mortem Examination and Remarks.
1 guinea-pig - -	Died 7	Too early to show tubercle.
1 do. -	Died 7	Do. do.
1 do. - -	Killed 123	Nil. Wound healed.
3		
Cat, inoculated subcutaneously.	Killed 123	Nil. Wound healed.

TABLE XC.

COW 28.

This animal was bought by the authorities of the Royal Veterinary College, Camden Town, and had been kept under observation for some time. She was much wasted, but there was no other marked evidence of the presence of tuberculosis. Killed at the slaughter-house at the Metropolitan Cattle Market at Islington.

Post-mortem Examination.—No tubercle of any of the *serous membranes.* Small recently developed tubercle nodules on the *glands* at the root of the lung, but none in the lung itself, and a few grey gelatinous-looking patches in the lumbar gland just at the margin of the pelvis. No trace of tubercle in any other organ of the body. Muscle of buttock kept for feeding experiment.

Meat.—Feeding Experiments.

Animals.	Part of Meat used and Amount and Duration of Feeding.	Killed or Died; No. of Days.	Post-mortem Examination and Remarks.
1 guinea-pig - - - - -	Mixed muscle from buttock, intercostal and abdominal wall, plunged in boiling water 5 minutes; 6 feedings; 300 grammes ($10\frac{1}{2}$ ozs.) collectively - - - - -	Killed 69 - - -	Nil.
1 do. - - - -		Killed 166 - - -	Nil.
1 do. - - - - -		Killed 170 - - -	Nil.
3			

TABLE XCI.

COW 29.

The meat from this cow was sent from the Metropolitan Slaughter-Houses, Islington. Neither I nor my assistant was present to see the carcase. Mr. Rayment, the Chief Inspector, informed me that the lungs, pleura, and peritoneum were badly affected with tubercle.

Meat.—Feeding Experiments.				Subcutaneous Inoculation and Intraperitoneal Injection Experiments.		
Animals.	Part of Meat used and Amount and Duration of Feeding.	Killed or Died; No. of Days.	Post-mortem Examination and Remarks.	Animals.	Killed or Died; No. of Days.	Post-mortem Examination and Remarks.
1 guinea pig	2 kilos 100 grammes (4 lbs. 9½ ozs.) buttock, plunged in boiling water 10 minutes; 3 feedings; 450 grammes (16 ozs.) collectively -	Killed 55	Nil. Lumbar glands slightly enlarged, but not tubercular.			
1 do.		Killed 55	Nil.			
1 do.		Killed 86	Nil.			
1 do.		Killed 86	Nil.			
1 do.		Killed 86	Nil.			
1 do.		Killed 86	Nil.			
6						
1 kitten	370 grammes (13 ozs.) of the above	Died 4	Too early to show tubercle.			
1 guinea-pig	1 kilo 500 grammes (3 lbs. 4½ ozs.) loin, boiled 40 minutes; 3 feedings; 450 grammes (16 ozs.) collectively - -	Killed 55	Nil.			
1 do.		Killed 55	Nil.			
1 do.		Killed 86	Nil.			
1 do.		Killed 86	Nil.			
1 do.		Killed 86	Nil.			
1 do.		Killed 86	Nil.			
6						
1 guinea-pig	2 kilos 300 grammes (5 lbs.) buttock, roasted 1 hour 10 minutes; 3 feedings; 450 grammes (16 ozs.) collectively	Killed 55	Nil.			
1 do.		Killed 55	Nil.			
1 do.		Killed 86	Nil.			
1 do.		Killed 86	Nil.			
1 do.		Killed 86	Nil.			
1 do.		Killed 86	Nil.			
6						
1 guinea-pig	Tuberculous gland, boiled 20 minutes; 3 feedings; 150 grammes (5 ozs.) collectively	Killed 93	Nil.	2 guinea-pigs, subcutaneously, piece of gland.	Killed 54 Killed 90	Nil. Wound healed. Nil. do.
1 do.		Killed 93	Nil.	2 guinea-pigs, 2 cc. emulsion of gland intraperitoneally.	Killed 54 Killed 93	Nil. Nil.
2				4		

TABLE XC.—*cont.*

Meat.—Feeding Experiments—*cont.*

Animals.	Part of Meat used and Amount and Duration of Feeding.	Killed or Died; No. of Days.	Post-mortem Examination and Remarks.
	Raw tubercular glands -	- - -	No feedings.

Subcutaneous Inoculation and Intraperitoneal Injection Experiments—*cont.*

Animals.	Killed or Died; No. of Days.	Post-mortem Examination and Remarks.
2 guinea-pigs, subcutaneously, piece raw gland.	Killed 54	**Tubercular.** Wound not healed, edges indurated, hard dry scar on dirty, sloughy surface; glands in groin, axilla, and neck enlarged, tubercular; liver, lungs, mediastinal and bronchial glands, tubercular.
	Killed 63	**Tubercular.** Wound healed, but liver, spleen, and lungs distinctly tubercular; enlargement of glands not so marked.
2 guinea-pigs, intraperitoneally, 2 cc. emulsion of raw gland.	Killed 53	**Tubercular.** Advanced stage. Peritoneal lining of abdomen and omentum studded with tubercle; spleen, liver, pancreas, and capsule of kidney tubercular; tubercle spreading along lymphatics of diaphragm. On microscopic examination tubercle bacilli found.
	Killed 63	**Tubercular.** Also advanced. Peritoneal tubercle not so marked as above; liver and spleen very tubercular; early tubercle in lungs.
4		

TABLE XCII.

COW 30.

Post-mortem Examination.—Cow killed at Metropolitan Slaughter-Houses and dressed before we arrived, so that a complete examination could not be made. The meat appeared to be sound. *Lungs and Glands in Thorax.*—Tubercle very well marked.

Feeding Experiments.

Animals.	Part of Meat used and Amount and Duration of Feeding.	Killed or Died; No. of Days.	Post-mortem Examination and Remarks.
1 guinea-pig	1 kilo 200 grammes (2 lbs. 10 ozs.) rump, plunged in boiling water 5 minutes; 3 feedings; 440 grammes (15½ ozs.) collectively - -	Killed 72	Nil.
1 do.		Killed 72	Nil.
1 do.		Killed 100	Nil.
1 do.		Killed 100	Nil.
1 do.		Killed 100	Nil.
1 do.		Killed 100	Nil.
6			
1 guinea-pig	3 kilos 900 grammes (8 lbs. 8½ ozs.) rump, roasted 2 hours; 3 feedings; 440 grammes (15½ ozs.) collectively - -	Died 47	Nil.
1 do.		Died 47	Nil.
1 do.		Killed 72	Nil.
1 do.		Died 97	Nil.
1 do.		Killed 100	Nil.
1 do.		Killed 100	Nil.
6			

Subcutaneous Inoculation Experiments.

Animals.	Killed or Died; No. of Days.	Post-mortem Examination and Remarks.
1 guinea-pig - -	Died 75	Nil.
1 do. - -	Killed 100	Nil. Wound healed.
2		
1 guinea-pig - -	Killed 100	Nil. Wound healed.
1 do. - -	Killed 100	Nil. do.
2		

TABLE XCIII.

COW 31.

Post-mortem Examination.—Cow killed at Metropolitan Slaughter-Houses, where a complete examination could not be made as the carcase had been dressed and the organs removed before we arrived. Meat was very dark in colour and lean, any fat there was was dark yellow in colour. The carcase, in fact, had a very unhealthy appearance.

Parietal Pleura.—Covered with grapes.
Lungs.—Well marked tubercle.
Diaphragm.—Covered with grapes.
Other organs not seen by us, but said to be tubercular.

Meat.—Feeding Experiments.

Animals.	Part of Meat used and Amount and Duration of Feeding.	Killed or Died; No. of Days.	Post-mortem Examination and Remarks.
1 guinea-pig	1 kilo 960 grammes (4 lbs. $4\frac{1}{2}$ ozs.) meat from thigh plunged in boiling water 10 minutes; 3 feedings; 440 grammes ($15\frac{1}{2}$ ozs.) collectively - -	Died 8	Too early to show.
1 do.		Killed 72	Nil.
1 do.		Killed 100	Nil.
1 do.		Killed 100	Nil.
1 do.		Killed 100	Nil.
1 do		Killed 100	Nil.
6			
1 guinea-pig	3 kilos 580 grammes (7 lbs. $13\frac{1}{4}$ ozs.) rump roasted 3 hours; 3 feedings; 440 grammes ($15\frac{1}{2}$ ozs.) collectively - - -	Died 6	Too early to show.
1 do.		Died 3	Do.
1 do.		Killed 72	Nil.
1 do.		Killed 100	Nil.
1 do.		Killed 100	Nil.
1 do.		Killed 100	Nil.
6			
1 kitten	**Raw grapes from ribs;** 1 feeding - -	Killed 257	**Tubercular.** Mesenteric glands very hard, and contained small spicules of calcareous matter embedded in a small quantity of caseous material; bronchial glands enlarged, contained firm caseo-purulent matter; small hard, irregular patches in lung apparently not tubercular. Tubercle bacilli found in mesenteric gland. Sections of lung showed other rod-shaped bacteria, but no tubercle bacilli.
1 cat		Killed 237	**Tubercular.** Tubercle of mesenteric glands only, which were enlarged, hard, and contained a small quantity of pus, in which tubercle bacilli were found.
2			

Subcutaneous Inoculation Experiments.

Animals.	Killed or Died; No. of Days.	Post-mortem Examination and Remarks.
1 guinea-pig -	Killed 72	Nil. Wound healed.
1 do. - -	Killed 100	Nil. do.
2		

TABLE XCIII—*cont.*

Meat.—Feeding Experiments—*cont.*				**Subcutaneous Inoculation Experiments**—*cont.*		
Animals.	Part of Meat used and Amount and Duration of Feeding.	Killed or Died; No. of Days.	Post-mortem Examination and Remarks.	Animals.	Killed or Died; No. of Days.	Post-mortem Examination and Remarks.
1 guinea-pig	**Raw grapes from ribs;** 1 feeding.	Died 45	**Tubercular.** Mesenteric and caecal glands enlarged, cheesy or gelatinous looking, evidently tubercular. Mesenteric glands photographed.			
1 do.		Died 44	**Tubercular.** Early tubercle. Localised area of tubercle in caecum, opaque points not yet caseating at lower end of small intestine. Mesenteric glands enlarged, indurated, contained yellow pus; liver normal; pancreas, spleen, lungs, early tubercle. Tubercle bacilli found.			
1 do.		Died 90	**Tubercular.** Intestines, mesenteric glands, glands in neck and at root of lungs, spleen, liver, lungs, tubercular.			
1 do.		Died 92	**Tubercular.** Tubercle localised in mesenteric glands and intestines. Tubercle bacilli found.			
1 do.		Died 123	**Tubercular.** Every organ and gland in the body tubercular. Large number of tubercle bacilli found in mesenteric glands.			
5						
1 guinea-pig	**Raw tubercular lung;** 1 feeding.	Died 43	**Tubercular.** Early tubercle. Mesenteric glands enlarged, hard, and caseous in centre; small grey points in spleen and in solitary glands of small intestine.			
1 do.		Died 47	**Tubercular.** Glands of intestines enlarged; mesenteric glands enlarged and caseous; liver one or two greyish nodules. Tubercle bacilli found.			
1 do.		Died 47	**Tubercular.** Similar to above, but spleen also affected. Tubercle bacilli found.			
1 do.		Died 116	**Tubercular,** advanced stage. Similar to above, but more advanced in intestines.			
4						

TABLE XCIV.

COW 32.

This animal was obtained for us by the late Principal Walley, of Edinburgh.

Post-mortem Examination.—Killed at Royal Veterinary College, Camden Town. Animal extremely emaciated and flesh dark and sodden.

THORAX:

Lungs.—Slight pleurisy, especially over the lower lobe of the right lung. Some congestion.

Bronchial and Posterior Mediastinal Glands.—Enlarged, pigmented, very tough, showing on section small caseous tubercular areas.

Heart.—Well marked pericarditis.

ABDOMEN:

Great Omentum.—On surface at upper part gelatinous exudation, like early grapes, also on parietal peritoneum opposite. No general tubercular peritonitis.

Liver, Spleen, and Pancreas.—Normal.

Kidneys.—Left, on section shows three hard caseous areas, one softening in centre, at apices of three pyramids. Right, four similar patches. Scattered miliary granulations in both kidneys.

Suprarenal Bodies.—Both infiltrated and almost completely destroyed by hard caseating tubercle.

Intestines.—No tubercle; well-marked catarrh.

Glands around the Large Intestine.—Splenic and sigmoid flexures are enormously enlarged; comparatively early tubercle, in the form of small nodules throughout the glands but not running together. The mass of glands would weigh several pounds.

Lymphatic Glands around cæcum and pancreas contain caseous tubercle.

Mesenteric Glands.—Show extensive caseous tubercle and are much enlarged.

Uterus.—One horn markedly tubercular, the other only slightly affected. Contained a quantity of muco-purulent pus, which on microscopic examination was found to be swarming with bacilli. The attachments of the cotyledons intensely congested, whole mucous membrane the same, but not so advanced. In the wall of the horn in which the tuberculosis is more advanced, yellow caseous masses appear to have taken the place of the muscular fibres, but these have probably been developed in the connective tissue, the muscular fibre being atrophied. This horn is much larger than the other. The lymphatic glands directly connected with the uterus are enormously enlarged, and in some cases contain large caseous masses. The greatest enlargement of the gland is at the splenic flexure on the side of the horn most affected.

Orifice of Vagina.—Much inflamed.

Udder.—Right quarters greatly enlarged, about twice natural size; about normal in colour; shows no evident congestion or tubercle. Lymphatic glands behind are enlarged and tough. No tubercle. Left lobes apparently normal, as are also lymphatic glands behind.

Meat.—Feeding Experiments.

Animals.	Part of Meat used and Amount and Duration of Feeding.	Killed or Died; No. of Days.	Post-mortem Examination and Remarks.
	Meat boiled 45 minutes - -	...	No feedings.
1 guinea-pig	**Raw Flank (Abdominal Walls) (controls)**; 3 feedings; 600 grammes collectively - - - -	Died 63	Nil.
1 do.		Died 70	Nil.
1 do.		Died 98	Nil.
1 do.		Died 115	Nil, so far as remnants of organs not eaten by other guinea-pigs would permit of examination.
1 do.		Killed 151	Nil.
1 do.		Killed 151	Nil.
6			

Subcutaneous Inoculation Experiments.

Animals.	Killed or Died; No. of Days.	Post-mortem Examination and Remarks.
1 guinea-pig - -	Died 2	Too early to show tubercle.
1 do. - -	Died 3	Do. do.
1 do. - -	Killed 151	Nil; wound healed.
3		
1 guinea-pig (control).	Died 1	Too early to show.
1 guinea-pig (control).	Died 1	Do.
1 guinea-pig (control).	Killed 151	**Tubercular.** Advanced tuberculosis; no trace of wound except some slight induration; glands in groin enlarged; mesenteric glands enlarged, tubercular; spleen tubercular and adherent to diaphragm and ribs; liver tubercular and adhering to under surface of diaphragm; some tubercular ulceration of the small intestine, cœliac glands, post-sternal glands, bronchial and posterior mediastinal glands and lung, all tubercular; on microscopic examination tubercle bacilli found.
3		

TABLE XCV.

COW 33.

Cow sent from Birkenhead by Dr. Sydney Marsden. All the physical signs of tuberculosis of lung well marked. Diarrhœa and great wasting, both indicative of intestinal affection. Temperature ranged between 102° and 104° and during the last fortnight did not fall below 103° C. The animal became so weak that she had to be killed. No evidence of tuberculosis of the udder.

Post-mortem Examination.—Animal very thin; no fat. Meat of good colour, but rather darker and more watery than normal.

THORAX:

Lungs.—Advanced tuberculosis in the posterior portion of the lower lobes. Little or no affection of the parietal pleura, only a single nodule here and there.

Anterior and Posterior Mediastinal Glands.—Markedly enlarged and in an advanced stage of tuberculosis; caseous, with calcareous points.

Heart.—Yellow patches on wall of left auricle.

ABDOMEN:

Liver and Spleen.—Both perfectly normal.

Kidneys.—One or two grey or yellow patches in cortex; too diffuse for tubercle.

Lumbar, Pelvic, and Popliteal Glands.—All normal.

Intestines, Large.—Normal, with exception of three or four small tubercular ulcers.

Intestines, Small.—About 40 swollen, spongy looking patches about the size of a pea (some of which are ulcerating); there are enlarged solitary glands, some congestion of the vessels which radiate to the margin of the patch from the small central ulcerated depression. Somewhat pinker than the surrounding membrane when seen from the peritoneal surface, but the margin is pinker, centre being pale yellow. *Carcase* normal.

Uterus.—Normal.

Meat.—Feeding Experiments.

Animals.	Part of Meat used and Amount and Duration of Feeding.	Killed or Died; No. of Days.	Post-mortem Examination and Remarks.
1 guinea-pig	Rump plunged in boiling water 10 minutes; 4 feedings: 400 grammes (14 ozs.) collectively	Died 74	**Tubercular.** Glands in neck, submaxillary and post mediastinal glands all tubercular; lungs congested, but show no evidence of tubercle; early tubercle of the liver and spleen and of the cœliac, mesenteric and mesocolic glands; slight enlargement and superficial ulceration of solitary glands in large intestine. Microscopic examination, tubercle bacilli found, but very few in number.
1 do.		Killed 84	Nil.
1 do.		Killed 84	Nil.
3			
1 pig	**Raw rump, control** 7 lbs (7,000 grammes), in several feedings.	Killed 85	**Tubercular.** One or two suspicious points in tonsils; one or two glands in neck slightly enlarged; lungs affected, one or two nodules in substance; evidently the lungs were attacked from pleural surface; early tubercle of bronchial and mediastinal glands; diaphragm well marked tubercle; spleen and liver only slightly affected, and so are the mesenteric glands. Intestines normal. Microscopic examination, tubercle bacilli found.

Subcutaneous Inoculation Experiments.

Animals.	Killed or Died; No. of Days.	Post-mortem Examination and Remarks.
1 guinea-pig	Died 14	Too early to show tubercle.
1 do.	Killed 84	Nil.
2		
1 guinea-pig (control).	Died 4	Too early to show tubercle.
1 do.	Killed 84	**Tubercular.** Inoculation wound still open, and edges hard and indurated; small tubercle nodules in subcutaneous tissue; inguinal glands and glands in axilla affected; liver, spleen, and lungs all extensively affected, as are also cœliac, posterior and anterior mediastinal glands and bronchial glands. Microscopic examination, tubercle bacilli found.
2		

TABLE XCV.—*cont.*

Meat.—Feeding Experiments—*cont.*

Animals.	Part of Meat used and Amount and Duration of Feeding.	Killed or Died; No. of Days.	Post-mortem Examination and Remarks.
1 guinea-pig	**Raw rump controls,** 3 feedings; 350 grammes (12¼ ozs.) collectively - -	Died 16	Too early to show tubercle.
1 do.		Killed 23	Do. do.
1 do.		Killed 84	**Tubercular.** Spleen obviously affected; liver only one or two very early points of tubercle; lungs normal; mesenteric glands along whole tract of intestine enlarged, and in some cases caseous, and peyers patches in intestine also affected. Microscopic examination, tubercle bacilli found.
3			

Subcutaneous Inoculation Experiments—*cont.*

Animals.	Killed or Died; No. of Days.	Post-mortem Examination and Remarks.

TABLE XCVI.

LUNG WITH ACUTE TUBERCULOSIS.

Acute miliary tuberculosis; a few caseous patches about the size of a pea, scattered over the lower part of the upper lobe and throughout the lower lobe. Numerous tubercle bacilli found in sections.

Meat.—Feeding Experiments.

Animals.	Part of Meat used and Amount and Duration of Feeding.	Killed or Died; No. of Days.	Post-mortem Examination and Remarks.
1 guinea-pig	½ kilo (1 lb. 1½ ozs.) tubercular human lung boiled 20 minutes; 4 feedings; 200 grammes (7 ozs.) collectively - -	Killed 158	Nil.
1 do.		Killed 204	Nil.
1 do.		Killed 204	Nil.
1 do.		Killed 204	Nil.
4			
	Raw Lung - - - -	...	No feedings.

Subcutaneous Inoculation Experiments.

Animals.	Killed or Died; No. of Days.	Post-mortem Examination and Remarks.
1 guinea-pig - -	Killed 205	Nil; inoculation wound healed.
1 do. - -	Killed 205	Nil; do. do.
2		
1 guinea pig, control.	Died 85	**Tubercular.** Well marked tuberculosis; animal emaciated; small caseous mass beneath healed wound at point of inoculation; tubercle nodules in neighbourhood of this mass in subcutaneous tissue; glands in groin on both sides enlarged, tubercular; no tubercle in thorax or axilla; mesenteric and cœliac glands enlarged and tubercular; small tubercle nodules in liver and spleen.
1 do. - -	Died 111	**Tubercular.** Extensive tuberculosis; wound still moist, had apparently broken out again; subcutaneous tubercle around seat of inoculation; mammary glands slightly enlarged; glands in groin, axilla, and neck, in fact all along left side, enlarged and tubercular; lungs, post-sternal, bronchial, and posterior mediastinal glands greatly enlarged, tubercular; liver, spleen, and pancreas all greatly enlarged and infiltrated with tubercle; omentum, peritoneum, and cœliac glands tubercular.
2		

PART XI.

Cooking (Roasting) Experiments with Meat purposely rendered Infective by the addition of obviously Tubercular Material.—("Smeared" Meat.)

PART XI.

TABLE XCVII.

Cooking (Roasting) Experiments with Meat purposely rendered Infective by the Addition of obviously Tubercular Material.—("Smeared" Meat).

(1.) Roasted 4 hours; 1 kilo (2 lbs. 3 ozs.) beef, smeared with tubercular lung of cow No. 23. Rolled, *overcooked*.

(2.) Roasted 2½ hours; 2 kilos 700 grammes (6 lbs.) sirloin from butcher (6″ × 6″), smeared with tubercular lung of cow No. 23, rolled, slightly *underdone*. Fusible metal (melting point 60° C.) placed at distances of 1½″ and 3″ from surface of joint; both melted. Fusible metal (melting point 70° C.) placed 2″ from surface; just melted.

(3.) Roasted 2 hours; 3 kilos 600 grammes (7 lbs. 14 ozs.) beef, smeared with tubercular lung of cow No. 18. Rolled. Fusible metal (melting point 60° C.) 4″ from surface of joint; not melted. Fusible metal (melting point 70° C.) 4″ from surface; not melted.

(4.) Roasted 2½ hours; 4 kilos (8 lbs. 12 ozs.) beef in which a cavity 3″ from surface had been filled, by means of a pipette, with 10 cc. of tubercular lung and glands from cow No. 25; *slightly underdone*.

(5.) Roasted 2½ hours; 3 kilos 600 grammes (8 lbs.) sirloin from butcher, smeared with tubercular caseous gland from cow No. 25, rolled; *well cooked*. Fusible metal (melting point 60° C.) 3″ from surface of joint; not melted. Fusible metal (melting point 70° C.) 2″ from surface; not melted.

(6.) Roasted 3¼ hours; 4 kilos 700 grammes (10 lbs. 5 ozs.) beef (10″ × 6″ × 6″), smeared with tubercular lung of cow No. 33; rolled. Fusible metal (melting point 60° C.) placed 3″ from surface; melted. Fusible metal (melting point 70° C.) placed 2″ from surface; not melted. Fusible metal (melting point 80° C.) placed ¾″ from surface; not melted. Fusible metal (melting point 80° C.) placed ½″ from surface; not melted.

The pig in this set of experiments was again fed with 3 kilos 150 grammes (7 lbs.) rolled beef, smeared with tubercular lung of a cow. Fusible metal (melting point 60° C.) placed 3″ from surface; not melted. Fusible metal (melting point 70° C.) placed 2″ from surface; not melted. Fusible metal (melting point 80° C.) placed 1½″ from surface; not melted. Thermometer reading 1″ from surface 63° C.)

(7.) Roasted 2 hours; 1 kilo 800 grammes (4 lbs.) beef, smeared with tubercular udder of cow sent from Metropolitan Cattle Market; rolled. Thermometer reading 1½″ from surface of joint 67° C., and still rising.

Feeding Experiments with Smeared Meat.

Material.	Animals.	Part of Meat used, and Amount and Duration of Feeding.	Killed or Died. No. of Days.	Post-mortem Examination and Remarks.
(1)	1 guinea-pig	Meat from outside and centre of joint, roasted 4 hours; 3 feedings; 300 grammes (10½ ozs. collectively.	Died 94	Nil.
	1 do.		Killed 123	Nil.
	1 do.		Killed 123	Nil.
	3			
	1 guinea-pig	**Raw meat smeared, controls 2 feedings; 500 grammes (1 lb. 1½ ozs.) collectively.**	**Died 19**	**Too early to show tubercle.**
	1 do.		**Died 68**	**Tubercular.** Spleen and mesenteric glands, and glands in neck, all distinctly tubercular; One or two small tubercular swollen patches in the small intestine. On microscopic examination tubercle bacilli were found in the spleen.
	1 do.		**Killed 119**	**Tubercular.** Numerous small well-defined tubercle nodules in the spleen; liver studded with minute points, and several well-defined larger patches; mesenteric glands enlarged, and yellow, and filled with soft purulent material. Although the centre is soft, the outer portion is hard and fibrous. A number of grey gelatinous points in the lungs. On microsopic examination tubercle bacilli were found.
	3			

Inoculation and Injection Experiments with Smeared Meat.

Animals.	Killed or Died. No. of Days.	Post-mortem Examination and Remarks.
1 guinea-pig inoculated subcutaneously with piece of meat from centre of roll.	Died 7	Too early to show tubercle.
1 do. do.	Died 21	Nil.
1 do. do.	Killed 123	Nil.
3		

TABLE XCVII.—*continued.*

Feeding Experiments with Smeared Meat—*cont.* | **Inoculation and Injection Experiments with unSeared Meat**—*cont.*

Material.	Animals.	Part of Meat used, and Amount and Duration of Feeding.	Killed or Died. No. of Days.	Post-mortem Examination and Remarks.	Animals.	Killed or Died. No. of Days.	Post-mortem Examination and Remarks.
(2)	1 guinea-pig -	Outside and centre of sirloin, roasted 2½ hours; 4 feedings; 500 grammes (1 lb. 1½ oz.) collectively.	Died 68 - -	Nil.	1 guinea-pig inoculated subcutaneously with a piece of meat 2" from surface of roll.	Died 24 - -	Nil.
	1 do. -		Died 84 - -	Nil.	1 do. do. -	Died 28 - -	Nil.
	1 do. -		Died 85 - -	Nil. Spleen had two yellowish nodules on it, about the size of a pea, which on opening were found to contain pus; microscopic examination shows degenerating cells; leptothrix form of bacilli stained blue, but no evidence of tubercular structure or bacilli.	1 do. 3" do. -	Died 24 - -	Nil.
	3	Controls from No. 1. serve for this set also.			1 do. do. -	Killed 119 - -	Nil.
					4		
	1 guinea-pig	**Raw meat smeared, controls 2 feedings; 500 grammes (1 lb. 1½ ozs.) collectively.**	**Died 19** -	**Too early to show tubercle.**			
	1 do. -		**Died 68** -	**Tubercular.**			
	1 do. -		**Killed 119** -	**Do.**			
	3						
(3)	1 cat - -	Outside and centre of meat, roasted 2 hours; several feedings; 1,125 grammes (2½ lbs.) in all.	Killed 190 -	Nil. Mesenteric gland on section showed two suspicious points. Microscopic examination, no tubercle bacilli, or tubercular structure could be found.	1 guinea-pig injected intraperitoneally with 2½ cc. emulsion made from meat taken from the centre of roast, 2 hours.	Died 2 - -	Too early to show tubercle.
					1 do. do. -	Died 2 - -	Do. do.
					1 do. do. -	Died 2 - -	Do. do.
					1 do. do. -	Died 3 - -	Do. do.
					1 do. do. -	Died 4 - -	Do. do.
					5		
	1 cat - -	**Raw tubercular material controls; about 500 grammes (1 lb. 1½ ozs.); in several feedings.**	**Killed 94** -	**Tubercle of mesenteric glands only. Tubercle bacilli found.**			
(4)	1 guinea-pig -	Outside and centre of beef, roasted 2½ hours; 1 feeding; 100 grammes (3½ ozs.) collectively.	Killed 114 -	Nil.	1 guinea-pig injected subcutaneously 2 cc. emulsion of beef, roasted 2½ hours.	Died 3 - -	Too early to show tubercle.
	1 do. - -		Killed 114 -	Nil.	1 do. do. -	Died 3 - -	Do. do.
	2				1 do. intrap., 1 cc. -	Died 44 - -	**Tubercular.** On opening the abdominal cavity small tubercles were seen scattered over its wall; pancreas was attached to anterior wall of the abdomen, and was apparently extensively tubercular; spleen and liver very much affected; lungs and bronchial glands and the chain of glands in the thorax all tubercular; thoracic cavity filled with fluid. Microscopic examination, tubercle bacilli found.
					1 do. do. -	Died 49 - -	**Tubercular.** Condition much the same as above, but pancreas unaffected. Microscopic examination, tubercle bacilli found.
					4		

TABLE XCVII.—*continued.*

Feeding Experiments with Smeared Meat—*cont.*					Inoculation and Injection Experiments with Smeared Meat—*cont.*		
Material.	Animals.	Part of Meat used, and Amount and Duration of Feeding.	Killed or Died. No. of Days.	Post-mortem Examination and Remarks.	Animals.	Killed or Died. No. of Days.	Post-mortem Examination and Remarks.
	1 Guinea-pig	**Raw tubercular material controls; 25 grammes (1 oz.) collectively.**	**Died 33** -	**Tubercular.** Mesenteric glands enlarged and hard; intestines normal; spleen slightly enlarged and covered with early tubercle nodules; very early affection of the liver; lungs had a number of greyish yellow nodules; glands on chest wall slightly enlarged. Microscopic examination, tubercle bacilli found.			
	1 do. -		**Killed 56** -	**Tubercular.** Mesenteric glands enormously enlarged and intestines ulcerated; well marked tubercle of the liver and spleen; lungs adherent to the chest wall and contain large masses of tubercle; mediastinal and bronchial glands and glands behind the sternum and in the jaw and neck all enlarged and tubercular. Microscopic examination, tubercle bacille found.			
	1 do. -		**Killed 56** -	**Tubercular.** Very similar condition to above. Microscopic examination, tubercle bacilli found.			
	3						
(5)	1 cat - -	Outside and centre of beef, roasted 2½ hours; 3 feedings; about ½ a kilo (1 lb. 1½ oz.)	Killed 129 -	Nil.	1 guinea-pig, injected subcutaneously, 2 cc. emulsion from outside of meat, roasted 2½ hours.	Killed 109 -	**Tubercular.** Ulceration of abdominal wall at point of injection; inguinal glands on both sides much enlarged, and filled with cheesy pus; mesenteric and posterior abdominal glands tubercular; spleen obviously affected; tubercle just commencing in the liver; several fine points in the lungs; bronchial and anterior and posterior mediastinal glands all tubercular. Microscopic examination, tubercle bacilli found.
	1 guinea-pig -	Outside of roast, 2½ hours; 2 feedings; 400 grammes (14 ozs.) collectively.	Died 39 - -	Nil.	1 do. do. -	Died 103 -	**Tubercular.** Abscess with soft caseous pus at point of injection; inguinal glands on same side affected; spleen, liver, and pancreas markedly tubercular; mesenteric, cœliac, and glands in hilus of liver all enlarged; diaphragm studded with tubercles; lungs, bronchial, sub-maxillary poststernal, post-mediastinal, and other glands in neck all tubercular. Microscopic examination, tubercle bacilli found.
	1 do. -		Killed 114 -	Nil.	1 guinea-pig, injected intraperitoneally with 1 cc. emulsion of do.	Died 9 - -	Too early to show tubercle.
	1 do. -		Killed 114 -	Nil.	1 do. do. -	Died 12 - -	Do. do.
	4				4		

TABLE XCVII.—*continued.*

Feeding Experiments with Smeared Meat—*cont.*

Material.	Animals.	Part of Meat used, and Amount and Duration of Feeding.	Killed or Died. No. of Days.	Post-mortem Examination and Remarks.
	1 guinea-pig -	Centre of roast, 2½ hours; 2 feedings; 400 grammes (14 ozs.) collectively.	Died 3 - -	Too early to show.
	1 do. -		Died 84 - -	Nil. Broncho pneumonia.
	1 do. -		Died 103 - -	**Tubercular.** Intestines slightly affected, and mesenteric glands enlarged, as are also the mesocolic glands and the glands in the hilus of the liver; spleen and liver both affected; lungs tubercular; bronchial and postmediastinal glands tubercular. Microsocpic examination, tubercle bacilli found.
	3			
	1 guinea-pig	**Raw tubercular material (controls); 1 feeding; 25 grammes (1 oz.) collectively.**	**Died 33** -	**Tubercular.** Mesenteric glands enlarged and hard; intestines normal; spleen slightly enlarged and nodular; very early affection of liver; lungs a number of greyish yellow nodules; glands on chest wall slightly enlarged. Microscopic examination, tubercle bacilli found.
	1 do. -		**Killed 56** -	**Tubercular.** Mesenteric glands enormously enlarged, and intestines ulcerated; well marked tubercle of the liver and spleen; lungs adherent to the chest wall, and contain large masses of gelatinous and caseating tubercle; mediastinal and bronchial glands and glands behind the sternum and under the jaw and in the neck, all enlarged, caseous and tubercular. Microscopic examination, tubercle bacilli found.
	1 do. -		**Killed 56** -	**Tubercular.** Very similar condition to above. Microscopic examination, tubercle bacilli found.
	3			

Inoculation and Injection Experiments with Smeared Meat—*cont.*

Animals.	Killed or Died. No. of Days.	Post-mortem Examination and Remarks.
1 guinea-pig, injected subcutaneously with 2 cc. emulsion from centre of meat, roasted 2½ hours	Killed 109 -	**Tubercular.** Wound still open with indurated edges; right inguinal gland open and suppurating, and lymphatic glands enlarged and filled with purulent material over chest and abdomen; spleen manifestly tubercular; early affection of liver; lymphatic glands in abdomen tubercular; lungs, only two or three slate grey patches; glands in thorax normal. Microscopic examination, tubercle bacilli found.
1 do. do. -	Killed 109 -	**Tubercular.** Abdominal organs and lymphatic glands affected much the same as in above case. Lungs, several grey patches of tubercle; anterior and posterior and mediastinal and bronchial glands all affected. Microscopic examination, tubercle bacilli found.
1 guinea-pig, injected intraperitoneally with 1 cc. emulsion of do.	Died 10 - -	Too early to show tubercle.
1 do. do. -	Died 48 - -	**Tubercular.** Spleen apparently commencing tubercle; liver, several greyish points at root near glands, and glands in hilus of liver enlarged and full of hard pus; lungs, one greyish nodule on lower lobe. Microscopic examination, tubercle bacilli found.
4		

TABLE XCVII.—*continued.*

Feeding Experiments with Smeared Meat—*cont.*

Material.	Animals.	Part of Meat used, and Amount and Duration of Feeding.	Killed or Died. No. of Days.	Post-mortem xamination and Remarks.
(6)	1 guinea-pig -	Outside and centre of roast, 3¼ hours; 4 feedings; 300 grammes (10½ ozs.) collectively.	Died 10 - -	Too early to show tubercle.
	1 do. -		Died 58 - -	**Tubercular.** Spleen and liver affected, also the following glands, viz., small mesenteric, at the hilus of the liver, cœliac, bronchial and poststernal; lungs apparently normal. Microscopic examination, tubercle bacilli found.
	1 do. -		Killed 84 - -	**Tubercular.** Spleen nodular; apparently early tubercular points in the liver; mesenteric glands throughout the whole tract enlarged and caseous; lungs normal; mediastinal glands slightly enlarged. Microscopic examination, tubercle bacilli found.
	1 do. -		Killed 84 - -	**Tubercular.** Condition same as above. Microscopic examination, tubercle bacilli found.
	4			
	1 pig - -	Outside and centre of roast, 3¼ hours; several feedings = 2½ kilos. (5 lbs. 7½ ozs.). Outside and centre of roast, 2½ hours; several feedings; 3½ kilos. (7 lbs. 10½ ozs.).	Killed 85 - -	**Tubercular.** Tonsils normal; one or two slightly enlarged glands in the neck; a few small tubercular glands behind the sternum; pleura of the right lung covered with small tubercle nodules, and in the septa of left lung one or two grey nodules; bronchial glands also affected; a few small grey tubercles in the liver; spleen and kidneys normal; mesenteric glands only slightly affected; intestines normal. Microscopic examination, tuberclo bacilli found.
	1 pig - -	**Raw tubercular material (control).**	**Died 42** -	**Tubercular.** On each tonsil were numerous small ulcers and nodules of yellow tubercle; the sublingual and submental glands were caseous, and from these extended a chain of caseous glands down to each axilla; the anterior and posterior mediastinal, bronchial cœliac, cæcal and mesenteric glands were all enlarged and caseous; lungs showed a few grey miliary tubercles, with marked consolidation of left lobe; numerous yellowish patches in the liver; spleen infiltrated with miliary tubercles throughout; in the large intestine were several small tubercles; every Peyers' patch in the small intestine was the subject of tubercular ulceration; other organs and parts normal. Microscopic examination, tubercle bacilli found.

Inoculation and Injection Experiments with Smeared Meat—*cont.*

Animals.	Killed or Died. No. of Days.	Post-mortem Examination and Remarks.
1 guinea-pig, injected subcutaneously with 2 cc. emulsion from centre of meat, roasted 3¼ hours.	Died 73 - -	**Tubercular.** Abscess at point of injection; cœliac and mesenteric glands, and those in the hilus of the liver, all affected; spleen and liver tubercular; only one or two nodules in the lungs; one bronchial gland, and the poststernal glands contained well marked tubercle. Microscopic examination, tubercle bacilli found.
1 do. do. -	Killed 84 - -	**Tubercular.** Condition similar to above, but more advanced in lungs. Microscopic examination, tubercle bacilli found.
1 guinea-pig, injected intraperitoneally with 1 cc. emulsion from do. do.	Died 10 - -	Too early to show tubercle.
1 do. do. -	Killed 84 - -	**Tubercular.** Mesenteric glands very much enlarged and hard; spleen and liver greatly enlarged and very tubercular; mediastinal glands also affected. Microscopic examination, tubercle bacilli found.
4		

TABLE XCVII.—*continued.*

Feeding Experiments with Smeared Meat—*cont.*

Material.	Animals.	Part of Meat used, and Amount and Duration of Feeding.	Killed or Died. No. of Days.	Post-mortem Examination and Remarks.
(7)	1 guinea-pig -	Outside and centre of roast, 2 hours; 4 feedings; 400 grammes (14 ozs.) collectively.	Died 38 - -	Nil.
	1 do. -		Died 17 - -	Too early to show tubercle. Lungs slightly broncho-pneumonic.
	1 do. -		Died 59 - -	Nil.
	3			
	1 pig - -	**Raw meat smeared, control; 1 kilo. (2 lbs. 3½ ozs.).**	**Killed 66** -	**Tubercular.** One gland on the right side of the neck tubercular; posternal, mediastinal, and bronchial glands greatly enlarged; several caseous yellow tubercles in the substance of the lungs, and a large number of small grey nodules on the surface; early grapes on the chest wall, and well marked grapes on diaphragm, which is adherent to the liver; liver, grey nodules, the size of a pea, scattered over the surface; half-a-dozen larger nodules in the spleen; cœliac glands and those at hilus of liver enlarged and tubercular; mesenteric glands slightly affected; small tubercle nodules only on the outer surface of the large intestine; other parts normal. Microscopic examination, tubercle bacilli found.
	1 guinea-pig	**Raw meat smeared, control; 3 feedings; 150 grammes (5 ozs.) collectively.**	**Died 16** -	Too early to show tubercle. Lungs, extensive pneumonic consolidation.
	1 do. -		**Killed 67** -	**Tubercular.** Mesenteric glands distinctly enlarged and affected; other organs normal. Microscopic examination, tubercle bacilli found.
	1 do. -		**Killed 67** -	**Tubercular.** Mesenteric glands distinctly enlarged and affected; other organs normal. Microscopic examination, tubercle bacilli found.
	3			

Inoculation and Injection Experiments with Smeared Meat—*cont.*

Animals.	Killed or Died. No. of Days.	Post-mortem Examination and Remarks.
1 guinea-pig, injected intraperitoneally with 1 cc. emulsion of meat, roasted 2 hours.	Died 41 - -	Nil.
1 do. do. -	Died 41 - -	Nil.
1 do. subcut. do. -	Died 58 -	Nil.
1 do. do. -	Killed 66 - -	Nil.
4		

TABLE XCVIII.

Cooking (Boiling) Experiments with Meat purposely rendered Infective by the Addition of Obviously Tubercular Material.

(1.) Boiled 1 hour 20 minutes; 2 kilos 700 grammes (6 lbs.) sirloin (6″ × 6″) from butcher, smeared with tubercular lung of cow No. 23; rolled Fusible metal (melting point 90° C.) placed 3″ from surface of joint, not melted.

(2.) Boiled 1½ hour; 3 kilos (6 lbs. 9 ozs.) beef, in which a cavity about 2½″ from the surface was filled by means of a pippette with 10 cc. of tubercular lung and glands from cow No. 25; *well-cooked*.

(3.) Boiled 2 hours; 3 kilos 600 grammes (8 lbs.) sirloin from butcher, smeared with caseous tubercular gland from Cow No. 25; rolled; outside overcooked; centre underdone. Fusible metal (melting point 60° C.) placed 3″ from surface of joint; just melting (plastic). Fusible metal (melting point 70° C.) placed 2″ from surface of joint; not melted. Fusible metal (melting point 80° C.) placed ½″ from surface of joint; melted.

(4.) Boiled 1¾ hours; 3 kilos 500 grammes (7 lbs. 10½ ozs.) beef (10′ × 6″ × 5″) smeared with tubercular lung of cow; rolled. Fusible metal (melting point 80° C.) placed 1¼″ from surface; melted. Fusible metal (melting point 90° C.) placed 1¼″ from surface; not melted.

The pig in this experiment was again fed with piece of smeared meat weighing 3 kilos 500 grammes (7 lbs. 10½ ozs.) smeared with tubercular lung of cow; rolled. Fusible metal (melting point 70° C.) placed 1½″ from surface, partially melted (plastic). Fusible metal (melting point 80° C.) 1½″ from surface; not melted. Fusible metal (melting point 90° C.) placed 1¼″ from surface; not melted. Thermometer reading 2″ from surface, 64° C. and still rising; 1½″ from surface, 68° C.; 1¼″ from surface, 63° C.; ⅜″ from surface 88° C.

(5.) Boiled 1¾ hours; 2 kilos 700 grammes (6 lbs.) beef, smeared with tubercular udder of cow sent from Metropolitan Cattle Market; rolled. Thermometer reading 2¼″ from surface of joint, 74° C.)

Feeding Experiments, with Smeared Meat—*cont.*

Material.	Animals.	Part of Meat used, and Amount and Duration of Feeding.	Killed or Died No. of Days.	Post-mortem Examination and Remarks.
1	1 guinea-pig	Outside and centre of meat from sirloin, boiled 1 hour and 20 minutes; 4 feedings; 500 grammes (1 lb. 1½ ozs.) collectively.	Killed 119	Nil.
	1 do.		Killed 119	Nil.
	1 do.		Killed 119	Nil.
	3			
	1 guinea-pig	**Raw meat, smeared, controls; 2 feedings; 500 grammes (1 lb. 1½ oz.) collectively.**	**Died 19**	Nil.
	1 do.		**Died 68**	**Tubercular.** Spleen, mesenteric glands, and glands in the neck, all distinctly tubercular; one or two small swollen tubercular patches in the small intestine. Microscopic examination, tubercle bacilli were found in the spleen.
	1 do.		**Killed 120**	**Tubercular.** Numerous small well-defined tubercle nodules in the spleen; liver studded with minute points, and several larger well-defined patches; mesenteric glands enlarged and yellow, outer portion hard and fibrous, central portion soft, and caseo purulent. A number of grey gelatinous points in the lung. Microscopic examination, tubercle bacilli found.
	3			

Inoculation Experiments, with Smeared Meat—*cont.*

Animals.	Killed or Died No. of Days.	Post-mortem Examination and Remarks.
1 guinea-pig inoculated subcutaneously with piece of meat taken from sirloin boiled 1 hour and 20 minutes. 3″ from surface.	Died 84	**Tubercular.** Glands in groin on both sides enlarged, and filled with pus; abdominal wall covered with tubercles; spleen nodular, and very much enlarged; liver extensively tubercular; other organs normal. Microscopic examination, tubercle bacilli found.
1 do. do.	Died 24	Nil.
1 do. 2″ do.	Died 9	Too early to show tubercle.
1 do. do. do.	Died 74	**Tubercular.** Inoculation wound still open and ulcerating; glands in groin on side of inoculation filled with yellow pus; mesenteric glands enlarged; spleen and liver markedly affected; large grey nodules in the lungs, and bronchial glands enlarged and cheesy. Microscopic examination, tubercle bacilli found.
4		

TABLE XCVIII.—*continued.*

Feeding Experiment with Smeared Meat—*cont.*

Materials.	Animals.	Part of Meat used, and Amount and Duration of Feeding.	Killed or Died. No. of Days.	Post-mortem examination and Remarks.
2	1 guinea-pig	Centre of meat, boiled 1½ hours; 1 feeding; 100 grammes (3½ ozs.) collectively.	Died 11	Too early to show tubercle.
	1 do.		Killed 114	Nil.
	2			
	1 guinea-pig	**Raw tubercular material, controls; 1 feeding; 25 grammes (1 oz.) collectively.**	**Died 33**	**Tubercular.** Spleen very slightly enlarged, and studded with tubercular points; very early tubercle of the liver; mesenteric glands enlarged, hard, and tubercular; glands on the wall of the chest somewhat enlarged, evidently tubercular. A number of small greyish yellow tubercular nodules in the lung. Microscopic examination, tubercle bacilli found.
	1 do.		**Killed 56**	**Tubercular.** Well marked tubercle of both liver and spleen; mesenteric glands enormously enlarged and caseous; ulcerated patches in both large and small intestines. Glands under the jaw and in the neck much enlarged and distinctly tubercular; also those behind the sternum and the mediastinal and bronchial glands, which are caseous throughout. The lungs, which are firmly adherent to the chest wall, contain large masses of gelatinous and caseating tubercle. In this case there has been infection from both the intestine and the pharynx. Microscopic examination, tubercle bacilli found.
	1 do.		**Killed 56**	**Tubercular.** Very similar in appearance to the above case. Microscopic examination, tubercle bacilli found.
	3			

Inoculation Experiments with Smeared Meat—*cont.*

Animals.	Killed or Died No. of Days.	Post-mortem examination and Remarks.
1 guinea-pig injected subcutaneously with 2 cc. emulsion from centre of meat, boiled 1½ hours.	Died 102	**Tubercular.** Tubercle at seat of injection, where there was a subcutaneous mass the size of a French bean; liver and spleen affected; cœliac glands, those at the hilus of the liver, mediastinal and bronchial glands, and glands in neck, all tubercular; lungs only slightly affected. Microscopic examination, tubercle bacilli found.
1 do. do.	Died 33	**Tubercular.** Disease localised. Gland in groin on one side very much enlarged and filled with soft pus; one or two very minute points in the liver. Spleen and pancreas apparently commencing to be affected; other organs normal.
1 do. injected intra-peritoneally with 1 cc. emulsion of do.	Died 42	Nil.
1 do. do.	Killed 109	Nil.
4		

TABLE XCVIII.—*continued.*

	Feeding Experiments with Smeared Meat—*cont.*				**Inoculation Experiments with Smeared Meat**—*cont.*		
Material.	Animals.	Part of Meat used, and Amount and Duration of Feeding.	Killed or Died. No. of Days.	Post-mortem Examination and Remarks.	Animals.	Killed or Died. No. of Days.	Post-mortem Examination and Remarks.
	1 cat	Outside and centre of meat from sirloin, boiled 2 hours; 3 feedings; ½ kilo. (1 lb. 1½ oz.)	Killed 128	Nil. Small purulent point in mesenteric gland. Microscopic examination shows pus cells, cocci and short bacilli, but no tubercle bacilli.	1 guinea-pig injected intra-peritoneally with 1 c.c. emulsion, taken 2″ from surface of meat boiled 2 hours.	Died 3	Too early to show tubercle.
	1 guinea-pig	Meat boiled 2 hours; 2″ from surface; 2 feedings; 400 grammes (14 ozs.) collectively.	Died 9	Too early to show tubercle.	1 do do.	Died 8	Do. do.
	1 do.		Killed 114	Nil.	1 guinea-pig injected sub-cutaneously with do.	Killed 109	**Tubercular.** Inguinal glands on both sides enlarged and filled with pus; spleen distinctly tubercular; early tubercle of the liver; anterior and posterior mediastinal and bronchial glands all affected; several grey patches in the lungs. Microscopic examination, tubercle bacilli found.
	1 do. 3		Killed 114	Nil.			
					1 do. do. 4	Died 102	**Tubercular.** Spleen, liver, and pancreas all distinctly affected; mesenteric, mesocolic, retroperitoneal, cæliac glands, and glands in hilus of liver all tubercular; tubercle on the outer wall of the bladder; lungs only slightly affected; bronchial, poststernal, mediastinal glands and glands in neck tubercular; well-marked spreading along the glands. Microscopic examination, tubercle bacilli found.
	1 guinea-pig	Meat boiled 2 hours; 3″ from surface; 2 feedings; 400 grammes (14 ozs.) collectively.	Killed 109	Nil.	1 guinea-pig injected intra-peritoneally with 1 c.c. emulsion, taken 3″ from surface of meat boiled 2 hours.	Died 9	Too early to show tubercle.
	1 do.		Killed 109	Nil.			
	1 do. 3		Killed 109	Nil.	1 do. do.	Died 51	**Tubercular.** Gland on one side slightly enlarged and yellow; spleen and liver much affected, as are also the glands in the hilus of the liver; diaphragm covered with tubercles; numerous grey nodules in the lungs; poststernal and mediastinal glands and glands in the neck, on both sides, enlarged; pancreas very tubercular. Microscopic examination, tubercle bacilli found.
					1 guinea-pig injected sub-cutaneously with do.	Killed 109	**Tubercular.** Glands on both sides of groin affected, and an appearance like grapes on chest wall; otherwise very similar to the above. Microscopic examination, tubercle bacilli found.
					1 do. do. 4	Died	**Tubercular.** Spleen, liver, and omentum extensively tubercular; cæliac and mesenteric glands enlarged and caseous; lungs pneumonic, and a few miliary tubercles; anterior and posterior mediastinal, bronchial and cæcal glands all enlarged. Microscopic examination, tubercle bacilli found.

TABLE XCVIII.—*continued.*

Feeding Experiments with Smeared Meat—*cont.* | **Inoculation Experiments with Smeared Meat**—*cont.*

Material.	Animals.	Part of Meat used, and Amount and Duration of Feeding.	Killed or Died. No. of Days.	Post-mortem Examination and Remarks.	Animals.	Killed or Died. No. of Days.	Post-mortem Examination and Remarks.
	1 guinea-pig	**Raw tubercular material; control; 25 grammes (1 oz.) collectively.**	**Died 33**	**Tubercular.** Spleen slightly enlarged, and studded with tubercle; early tubercular affection of the liver; mesenteric glands enlarged, hard, and tubercular; a number of greyish-yellow nodules in the lungs. Microscopic examination, tubercle bacilli found.			
	1 do.		**Killed 56**	**Tubercular.** Well marked tubercle of both liver and spleen; mesenteric glands enormously enlarged and caseous; ulceration of both large and small intestines; lungs firmly adherent to chest wall, and contain large masses of gelatinous caseating tubercle; glands behind the sternum, the mediastinal and bronchial glands and glands under the jaw and in the neck all affected. Microscopic examination, tubercle bacilli found.			
	1 do.		**Killed 56**	**Tubercular.** Very similar condition to above. Microscopic examination, tubercle bacilli found.			
	3						
4	1 guinea-pig	Outside and centre of meat, boiled 1¾ hours; 4 feedings; 500 grammes (1 lb. 1⅓ oz.) collectively.	Died 9	Too early to show tubercle.	1 guinea-pig injected subcutaneously with 2 c.c. emulsion of meat, boiled 1¾ hours.	Died 18	Nil.
	1 do.		Died 10	Do. do.			
	1 do.		Died 10	Do. do.	1 do. do.	Died 71	**Tubercular.** Caseous pus at point of injection; liver and spleen tubercular, and also mesenteric glands; lungs, bronchial, post mediastinal, poststernal glands in neck and supra clavicular glands all affected. Microscopic examination, tubercle bacilli found.
	1 do.		Killed 84	**Tubercular.** Spleen enlarged, and contains seven good-sized nodules; liver also tubercular; intestines in an advanced stage of tuberculosis, and mesenteric glands along whole tract enormously enlarged, and, in neighbourhood of cæcum, caseating; other parts normal. Microscopic examination, tubercle bacilli found.			
	4				1 do. intraperitoneally do.	Died 3	Too early to show tubercle.
					1 do. do.	Killed 84	**Tubercular.** Glands in groin on both sides enlarged; spleen, liver, and pancreas very tubercular; mesenteric glands and mediastinal glands enlarged, and very early tubercle of the lungs. Microscopic examination tubercle bacilli found.
					4		
	1 pig	Outside and centre of meat, boiled 1¾ hours; 1½ kilos. (3 lbs. 4½ ozs.) Outside and centre of meat, boiled 1½ hours; 3½ kilos. (7 lbs. 10½ ozs.).	Killed 85	**Tubercular.** Abscess in tonsils; the glands in neck slightly enlarged; anterior and posterior mediastinal and bronchial glands enormously enlarged; in the right lung are a number of discrete nodules; left lung firmly adherent to the chest wall, the pleura of which is enormously thickened; well-marked grapes in part not adherent; retroperitoneal and cœliac glands tubercular; mesenteric glands slightly enlarged, hard and tubercular; only two tubercle nodules in the spleen, and these just commencing to caseate; liver mottled over with well-marked tubercle, as is also diaphragm; intestines normal. Microscopic examination. Tubercle bacilli found.			

TABLE XCVIII.—*continued.*

Feeding Experiments with Smeared Meat—*cont.*					Inoculation Experiments with Smeared Meat—*cont.*		
Material.	Animals.	Part of Meat used, and Amount and Duration of Feeding.	Killed or Died. No. of Days.	Post-mortem Examination and Remarks.	Animals.	Killed or Died. No. of Days.	Post-mortem Examination and Remarks.
	1 pig	**Raw tubercular material; control.**	**Died 42**	**Tubercular.** On each tonsil were numerous small ulcers and nodules of yellow tubercle; the sublingual and sub-mental glands were caseous, and from these extended a chain of caseous glands down to each axilla; the anterior and posterior mediastinal, bronchial, cœliac, cæcal, and mesenteric glands were all enlarged and caseous; lungs showed a few grey miliary tubercles, with marked consolidation of the left lobe; numerous yellow patches in the liver; spleen infiltrated with miliary tubercles; in the large intestine were several small tubercles; every peyers patch in the small intestine was the subject of tubercular ulceration. Microscopic examination, tubercle bacilli found.			
5	1 guinea-pig	Outside and centre of meat, boiled 1¾ hours; 4 feedings; 400 grammes (14 ozs.) collectively.	Died 38	Nil.	1 guinea-pig injected intra-peritoneally with 1 c.c. emulsion of meat, boiled 1¾ hours.	Killed 66	Nil.
	1 do.		Died 40	Nil.	1 do. do.	Killed 66	Nil.
	1 do.		Killed 66	Nil.	1 do. subcutaneously do.	Killed 66	Nil.
	3				1 do. do.	Killed 66	Nil.
					4		
	1 pig	**Raw meat, smeared; control; 1 kilo. (2 lbs. 3 ozs.)**	**Killed 66**	**Tubercular.** One gland in the neck on the right side tubercular; poststernal, mediastinal, and bronchial glands greatly enlarged; several caseous yellow tubercles in substance of the lungs, and a large number of small grey nodules on the surface of the lungs; early grapes on the chest wall, and well-marked grapes on the diaphragm, which is adherent to the liver; grey nodules the size of a pea on the surface of the liver; half a dozen larger nodules in the spleen; cœliac glands and those at the hilus of the liver enlarged and tubercular; mesenteric glands slightly affected; small tubercle nodules on the outer surface only of the large intestine; other parts normal. Microscopic examination, tubercle bacilli found.			
	1 guinea-pig	**Raw meat, smeared; control; 3 feedings; 150 grammes (5 ozs.) collectively.**	**Died 16**	**Too early to show tubercle.**			
	1 do.		**Killed 67**	**Tubercular.** Mesenteric glands distinctly enlarged and tubercular; other organs normal. Microscopic examination, tubercle bacilli found.			
	1 do.		**Killed 67**	**Tubercular.** Mesenteric glands distinctly enlarged and tubercular; other organs normal. Microscopic examination, tubercle bacilli found.			
	3						

PART XII.

Details of feeding and injection experiments made with tuberculous milk taken from Cows Nos. 20, 21, 24, and 25, suffering from tuberculosis of the udders:—

Table XCIX., heated at 60° C. (140° F.), p. 222.
Table C., heated at 70° C. (158° F.), p. 223.
Table CI., heated at 70° C. (158° F.), p. 226.
Table CII., heated at 70° C. (158° F.), p. 227

In all these tables the records of the experiments with heated milk are placed on the left side of the page, the control experiments on the right. The two halves of the table are identical, except that in the part on the left, in the second column, is given the time during which the milk was kept at any given temperature. The other four columns are alike in each half. In the first the numbers and species of the animals used are given; one of the other columns in each is devoted to the number of feedings or injections, the numbers of the materials used, and the total amount given in each case. In the next column is given the time, in days, at which the animal died or was killed after the commencement of the experiment; and in the last column are given the results of the post-mortem examination and any remarks or notes on the cases.

PART XII.

TABLE XCIX.

Tubercular Milk from Cow No. 20.

Experiments with Milk exposed to a temperature of 60° C. (140° F).

Feeding Experiments.

No. of Animals.	Time Sterilised.	Number and Amount of Feedings.	Killed or Died. No. of Days.	Post-mortem Examination and Remarks.
1 guinea pig	**15** minutes	100 cc. in 2 feedings	Died 147 -	Nil.
1 do. -	Do. -	Do. -	Killed 172 -	Nil.
1 do. -	Do. -	Do. -	Killed 172 -	Nil.
1 do. -	Do. -	Do. -	Killed 172 -	Nil.
1 do. -	Do. -	Do. -	Killed 172 -	Nil.
1 do. -	Do. -	Do. -	Killed 172 -	Nil.
6				
1 guinea-pig	**30** minutes	100 cc. in 2 feedings	Killed 169 -	Nil.
1 do. -	Do. -	Do. -	Killed 169 -	Nil.
1 do. -	Do. -	Do. -	Killed 169 -	Nil.
1 do. -	Do. -	Do. -	Killed 169 -	Nil.
1 do. -	Do. -	Do. -	Killed 169 -	Nil.
5				

Control Feeding Experiments with Raw Milk.

No. of Animals.	Number and Amount of Feedings.	Killed or Died. No. of Days.	Post-mortem Examination and Remarks.
1 guinea-pig	30 cc. in 2 feedings	Died 113 -	**Tubercular.** Beautiful tubercle of the peritoneum; spleen and liver markedly tubercular; diaphragm only slightly affected; glands behind sternum, thymus glands, posterior mediastinal and large glands at base of heart, all very tubercular; in the lung the tubercle is quite different from that seen in other specimens, and is more like the potato-nodule, tubercle, *i.e.*, with yellow centre and gelatinous pigmented outline; mesenteric glands enormously enlarged, and both small and large intestine and cæcum tubercular. Microscopic examination, tubercle bacilli found.
1 do. -	Do. -	Died 116 -	**Tubercular.** Spleen and pancreas enlarged and tubercular; liver and lungs also distinctly affected; bronchial and poststernal and mesenteric glands greatly enlarged; intestines ulcerated. Peritoneum in several places affected with tubercle following the lines of the lymphatics. Microscopic examination, tubercle bacilli found.
1 do. -	Do. -	Died 110 -	**Tubercular.** Liver, spleen, and lungs all tubercular; bronchial and poststernal glands also affected; mesenteric glands greatly enlarged; the large and small intestine and cæcum were all ulcerated. Microscopic examination, tubercle bacilli found.
3			

TABLE XCIX.—*continued.*

Injection Experiments.

No. of Animals.	Time Sterilised.	Intraperitonal Injection.	Killed or Died. No. of Days.	Post-mortem Examination and Remarks.
1 guinea-pig	**15** minutes	1 cc. - -	Died 80 -	**Tubercular.** A few tubercle nodules on the abdominal wall; retroperitoneal glands, gland in pelvis, mesenteric and mesocolic glands enlarged and caseous; liver, spleen, pancreas and omentum all markedly affected; glands in lesser curvature of stomach tubercular; early tubercle throughout the lungs; anterior mediastinal, poststernal, and cervical glands all tubercular. Microscopic examination, numerous tubercle bacilli found.
1 do. -	Do. -	1 cc. - -	Died 40 -	**Tubercular.** Small tubercles on the abdominal wall; spleen and liver enormously enlarged and tubercular; lungs contained numerous patches of caseous tubercle; anterior mediastinal bronchial and cervical glands all affected. Microscopic examination, tubercle bacilli found.
1 do. -	Do. -	1 cc. - -	Died 79 -	Nil.
3				
1 guinea-pig	**30** minutes	1 cc. - -	Died 23 -	Nil.
1 do. -	Do. -	1 cc. - -	Killed 172 -	Nil.
1 do. -	Do. -	1 cc. - -	Died 72 -	**Tubercular.** Well marked tubercle of peritoneum, omentum, and mesenteric glands; pancreas enormously enlarged; retroperitoneal glands and diaphragm and liver all affected; poststernal gland and thymus gland greatly enlarged, and cervical glands just commencing to be affected; lungs and mediastinal glands tubercular, and a few nodules seen in the costal pleura behind the ribs. Microscopic examination, tubercle bacilli found.
3				

Control Injection Experiments with Raw Milk.

No. of Animals.	Intraperitoneal Injection.	Killed or Died. No. of Days.	Post-mortem Examination and Remarks.
1 guinea-pig	5 cc. - - -	Died 18 -	**Tubercular** Tubercles on abdominal wall and mesentery; spleen, liver, and diaphragm tubercular; lungs and glands at root distinctly affected; glands behind the sternum tubercular. Microscopic examination, tubercle bacilli found.
1 do. -	1 cc. - - -	Died 20 -	**Tubercular.** Tubercle at point of injection, and deep inguinal and retroperitoneal (cœliac) glands affected; omentum contracted, a mass of young tubercles; mesenteric glands much enlarged; liver, spleen and diaphragm and glands behind the sternum all tubercular; lungs somewhat collapsed, with well developed catarrhal pneumonic tubercular patches. Microscopic examination, tubercle bacilli found.
1 do. -	1 cc. - - -	Died 17 -	**Tubercular.** Tubercles on abdominal wall and mesentery; intestines matted together; spleen, liver and diaphragm tubercular; lungs and glands at root distinctly affected; poststernal glands tubercular. Microscopic examination, tubercle bacilli found.
3			

TABLE C.

Tubercular Milk from Cow No. 21.

Experiments with Milk exposed to a Temperature of 70° C. (158° F.)

Feeding Experiments

No. of Animals.	Time Sterilised.	Number and Amount of Feedings.	Killed or Died. No. of Days.	Post-mortem Examination and Remarks.
1 guinea-pig	**5** minutes -	6 feedings = 60 cc.	Killed 93 -	Nil.
1 do. -	Do. -	Do. -	Died 18 -	Too early to show tuberculosis.
1 do. -	Do.	Do. -	Killed 93 -	Nil.
3				

Control Feeding Experiments with Raw Milk.

No. of Animals.	Number and Amount of Feedings.	Killed or Died. No. of Days	Post-mortem Examination and Remarks.
1 cat -	feedings = 1,650cc.	Killed 99 -	**Tubercular.** Animal much emaciated; glands near cæcum enormously enlarged, gelatinous or caseous, tubercular; cœliac glands slightly enlarged; spleen and liver normal; in the lungs are minute irregular areas, especially in the lower lobes, evidently tubercular; glands at root of lung normal; thymus gland distinctly tubercular. Microscopic examination, tubercle bacilli found.
1 kitten -	Do. -	Killed 151 -	**Tubercular.** One or two mesenteric glands distinctly tubercular; all the other organs normal.
2			

TABLE C.—*continued.*

Feeding Experiments—*cont.*

No. of Animals.	Time sterilised.	Number and Amount of Feedings.	Killed or Died. No. of Days.	Post-mortem Examination and Remarks.
1 pig	**5** minutes	3 feedings=3,000cc.	Killed 76	**Tubercular.** Tonsils apparently normal, but on the left side the submaxillary glands are tubercular; mediastinal and bronchial glands distinctly affected; a few small early tubercle nodules in the lung; liver, spleen, kidneys, and intestines normal; mesenteric and cœliac glands enlarged and caseous, distinctly tubercular.
1 guinea-pig	**10** minutes	6 feedings = 60 cc.	Killed 93	**Tubercular.** A large tubercular patch in the spleen; mesenteric glands enlarged and caseous; small tubercular patches in the lung, bronchial glands enlarged; other organs normal. Microscopic examination, tubercle bacilli found.
1 do.	Do.	Do.	Killed 93	Nil.
1 do.	Do.	Do.	Killed 93	Nil.
3				
1 pig	**10** minutes	3 feedings=3,000cc.	Killed 68	**Tubercular.** Slight tubercular infiltration of the walls of the pharynx; submaxillary glands and those near the parotid gland enlarged and caseating; mediastinal and bronchial glands caseous; early tubercle in the lung; four or five pea-sized tubercle nodules in the spleen, and numerous grey nodules in the liver; one or two follicular enlargements in the large intestine, apparently tubercular; mesenteric glands enlarged, with one or two tubercular points. In this case infection seems to have taken place both from the intestine and from the pharynx. Microscopic examination, tubercle bacilli found.
1 guinea-pig	**15** minutes	6 feedings = 60 cc.	Died 31	Nil. Liver had one suspicious patch. Miscroscopic examination failed to discover either tubercular structure or tubercle bacilli.
1 do.	Do.	Do.	Killed 93	**Tubercular.** Spleen very much enlarged, surface studded with light grey tubercular patches; a few tubercle nodules in the liver; mesenteric glands enlarged and caseous; intestines normal; a number of grey nodules in the lung; mediastinal and bronchial glands enlarged and caseous. Microscopic examination, tubercle bacilli found.
1 do.	Do.	Do.	Killed 93	Nil.
3				
1 pig	**15** minutes	3 feedings=3,000cc.	Killed 68	**Tubercular.** In the neck, extending from the tonsils and upper part of the pharynx is a chain of glands all enlarged, some caseous, others gelatinous, evidently in a state of early tuberculosis; lungs normal; posterior and anterior mediastinal glands enlarged; the only parts affected in the abdomen are the mesenteric and cœliac glands in which there is early tubercle. Microscopic examination, tubercle bacilli found.

Control Feeding Experiments with Raw Milk—*cont.*

No. of Animals.	Number and Amount of Feedings.	Killed or Died. No. of Days.	Post-mortem Examination and Remarks.
1 pig	1 feeding =1,000 cc.	Killed 116	**Tubercular.** Tonsils little, if at all, enlarged, but one or two tubercular noints may be seen in their substance; parotid and submaxillary glands enormously enlarged and infiltrated with tubercle; tubercular infiltration, but no ulceration of the uvula and soft palate; bronchial and mediastinal glands slightly enlarged; lungs normal; lymphatics in diaphragm affected on the right side; a few small tubercle nodules in the liver; mesenteric and cœliac glands somewhat enlarged; other organs normal; in this case the tubercle evidently spread from the pharynx. Microscopic examination, tubercle bacilli found.
1 pig	3 feedings=3,000cc.	Killed 116	**Tubercular.** Abscesses in the tonsils, evidently tubercular, ulcerating into pharynx; glands in neighbourhood, and running to the anterior portion of the jaw and down the neck forming continuous strings, are enormously enlarged and tubercular; small tubercle nodules in the mucous membrane of the uvula; tubercular ulceration of the mucous membrane of the inferior nasal fossæ; mediastinal and bronchial glands enormously enlarged; lungs tubercular throughout, but there are larger masses near the base; on the under surface of diaphragm are a large number of tubercles; small caseating tubercular points scattered over liver; large well-formed masses from size of a pea to that of filbert projecting from the surface of the spleen, many of them caseous; small tubercle nodules in both kidneys; mesenteric and cœliac glands enlarged and tubercular; intestines normal. Microscopic examination, tubercle bacilli found.
1 pig	9 feedings=9,000cc.	Killed 120	**Tubercular.** Small tubercular points in the pharynx and tonsils; glands in neck, under the jaw and at the root of the lung greatly enlarged and tubercular, forming a continuous chain between the tonsils, the angle of the jaw and the root of the lung; enormous masses of tubercle in the lung; tubercular granulations on the chest wall and upper surface of the diaphragm, these often causing adhesion of the visceral pleura; in other respects this animal presents a similar condition to the foregoing. Microscopic examination, tubercle bacilli found.
3			
1 guinea-pig	6 feedings = 60 cc.	Died 32	Nil.
1 do.	Do.	Died 81	**Tubercular.** Intestine, tubercular ulceration well marked; very little affection of mesenteric glands; spleen and liver both distinctly tubercular; cervical glands somewhat enlarged and tubercular; lungs normal. Microscopic examination, tubercle bacilli found.
1 do.	Do.	Killed 93	**Tubercular.** Intestines normal, but mesenteric and mesocolic glands enormously enlarged and cheesy; spleen distinctly tubercular; one or two tubercular patches in the liver; a number of small nodules in the lung, not all typical, but one or two undoubtedly tubercular. Microscopic examination, tubercle bacilli found.
3			
1 cat	Numerous feedings	Killed 197	**Tubercular.** Animal extremely emaciated; a single ulcerated patch in the intestines, which externally looked like a small abscess; mesenteric glands enlarged and cheesy; spleen studded with numerous yellow nodules; lungs made up almost entirely of yellow patches and a few gelatinous points; mediastinal and bronchial glands much enlarged.

TABLE C.—*continued.*

Injection Experiments.

No. of Animals.	Time Sterilised.	Intraperitoneal Injection.	Killed or Died. No. of Days.	Post-mortem Examination and Remarks.
1 guinea-pig	**5** minutes	1 cc.	Died 13	Too early to show tuberculosis. Congestion of chest wall.
1 do.	Do.	1 cc.	Killed 93	Nil.
1 do.	Do.	1 cc.	Killed 93	**Tubercular.** Spleen markedly tubercular; liver covered with small tubercular points and glands in hilus enlarged and tubercular; numerous tubercular patches throughout the substance of the lungs; bronchial glands enlarged and cheesy; glands in neck also enlarged and cheesy. Microscopic examination, tubercle bacilli found.
3				
1 guinea-pig	**10** minutes	1 cc.	Died 88	Nil.
1 do.	Do.	1 cc.	Killed 93	Nil.
1 do.	Do.	1 cc.	Killed 93	Nil.
3				
1 guinea-pig	**15** minutes	1 cc.	Killed 93	Nil.
1 do.	Do.	1 cc.	Killed 93	Nil.
1 do.	Do.	1 cc.	Killed 93	Nil.
3				
1 guinea-pig	**9** minutes	¾ cc.	Died 47	Nil.
1 do.	**10** minutes	¾ cc.	Died 31	Nil. Liver fatty and congestion of the lungs.
1 guinea-pig	**11** minutes	¾ cc.	Killed 77	**Tubercular.** Spleen not much enlarged, but a number of tubercle nodules in its substance; liver, three yellow tubercle nodules; lungs contained a single tubercle nodule; bronchial glands and those in the neck enlarged and cheesy, as are also the mesenteric glands.
1 do.	**12** minutes	¾ cc.	Died 73	**Tubercular.** Somewhat similar condition to the foregoing, but not so advanced. Microscopic examination, tubercle bacilli found.
1 do.	**13** minutes	¾ cc.	Killed 77	Nil.
1 do.	**14** minutes	¾ cc.	Killed 77	Nil.
1 do.	**15** minutes	¾ cc.	Killed 77	Nil.

Control Injection Experiments with Raw Milk.

No. of Animals.	Intraperitoneal Injection.	Killed or Died. No. of Days.	Post-mortem Examination and Remarks.
1 guinea-pig	1 cc.	Died 33	**Tubercular.** *Milk taken from left anterior teat.* Retroperitoneal glands, glands behind kidney, and capsule of kidney all tubercular; spleen, young gelatinous tubercle; liver studded with several nodules; diaphragm affected; lungs congested, but not tubercular; chest wall and poststernal glands tubercular.
1 do.	1 cc.	Died 53	**Tubercular.** *Milk taken from left anterior teat.* In liver, spleen, and omentum, well marked tubercle; under surface of diaphragm and glands behind ziphisternum, manubrium sterni and all along the left side of sternum tubercular; lungs and glands at root, markedly tubercular. Microscopic examination, tubercle bacilli found.
2			
1 guinea-pig	1 cc.	Died 32	**Tubercular.** *Milk from all four teats.* Peritoneal cavity, some tubercular peritonitis; retroperitoneal and mesenteric glands slightly tubercular; capsule of kidney affected; pancreas and liver tubercular, the latter adhering to the kidney; lungs studded with well marked coarse perivacular lymphatic tubercle; glands at root of lung and behind sternum markedly tubercular.
1 do.	1 cc.	Died 30	**Tubercular.** *Milk from all four teats.* Similar to the foregoing but kidney not affected; glands at hilus of liver, poststernal and mediastinal glands all enlarged and tubercular; falciform ligament tubercular. The bronchial glands in this case must have been affected before the lungs.
1 do.	1 cc.	Died 28	**Tubercular.** *Milk from all four teats.* Peritoneum studded with tubercles; glands in the abdomen very slightly affected; well marked tubercle of the diaphragm and liver; early tubercle of the spleen. Microscopic examination, tubercle bacilli found.
1 guinea-pig	¾ cc.	Died 29	**Tubercular.** *Milk from all four teats.* Abdominal and intestinal walls studded with well developed tubercle nodules; liver, spleen, and pancreas all markedly tubercular; glands not specially prominent. Microscopic examination, tubercle bacille found.
4			

TABLE CI.

Tubercular Milk from Cow No. 25.

Experiments with Milk exposed to a temperature of 70° C (158° F.)

Injection Experiments.

No. of Animals.	Time sterilised.	Intraperitoneal Injection.	Killed or Died. No. of Days.	Post-mortem Examination and Remarks.
1 guinea-pig	**2½** minutes	5 cc.	Died 20	Too early to show tubercle.
1 do.	Do.	5 cc.	Died 36	Nil.
1 do.	Do.	5 cc.	Killed 112	Nil.
3				
1 guinea-pig	**5** minutes	5 cc.	Died 3	Too early to show tubercle.
1 do.	Do.	5 cc.	Killed 113	Nil.
1 do.	Do.	5 cc.	Killed 113	Nil.
3				
1 guinea-pig	**10** minutes	5 cc.	Died 63	Nil.
1 do.	Do.	5 cc.	Killed 113	Nil.
1 do.	Do.	5 cc.	Killed 113	Nil.
3				
1 guinea-pig	**15** minutes	5 cc.	Died 11	Too early to show tubercle.
1 do.	Do.	5 cc.	Killed 112	Nil.
1 do.	Do.	5 cc.	Killed 112	Nil.
3				
1 guinea-pig	**20** minutes	5 cc.	Died 7	Too early too show tubercle.
1 do.	Do.	5 cc.	Died 21	Nil.
1 do.	Do.	5 cc.	Killed 112	Nil.
3				

Control Injection Experiments with Raw Milk.

No. of Animals.	Intraperitoneal Injection.	Killed or Died. No. of Days.	Post-mortem Examination and Remarks.
1 guinea-pig	5 cc.	Died 22	**Tubercular.** Early tubercle of the liver, spleen, and pancreas; glands in the neck enlarged. Microscopic examination, tubercle bacilli found.
1 do.	5 cc.	Died 25	**Tubercular.** Liver, spleen, and pancreas tubercular; early tubercle of the lungs. Microscopic examination, tubercle bacilli found.
1 do.	5 cc.	Died 25	**Tubercular** Well marked tubercle over the wall of the abdomen and in the pancreas; spleen enlarged and tubercular; marked tubercle of the liver; the lungs, and bronchial and mediastinal glands also distinctly affected. Microscopic examination, tubercle bacilli found.
3			

TABLE CII.

Tubercular Milk from Cow No. 24.

Experiments with Milk exposed to a temperature of 70° C. (158° F.).

Feeding Experiments.

No. of Animals.	Time Sterilised.	Number and Amount of Feedings.	Killed or Died. No. of Days.	Post-mortem Examination and Remarks.
1 guinea-pig	**15** minutes	15 feedings = 150 cc.	Killed 98	Nil.
1 do.	Do.	Do.	Killed 98	Nil.
1 do.	Do.	Do.	Killed 148	Nil.
3				
1 guinea-pig	**30** minutes	15 feedings = 150 cc.	Died 19	Too early to show tubercle. Pigmentation of intestinal glands.
1 do.	Do.	Do.	Killed 98	Nil.
1 do.	Do.	Do.	Killed 157	Nil. Intestinal gland slightly enlarged. On microscopic examination sections showed neither tubercle bacilli nor tubercular structure.
3				
1 guinea-pig	**60** minutes	15 feedings = 150 cc.	Died 30	Nil. Congestion of the peritoneal covering of the abdominal wall and abdominal organs.
1 do.	Do.	Do.	Killed 98	Nil.
1 do.	Do.	Do.	Killed 157	Nil.
3				

Control Feeding Experiments with Raw Milk.

No. of Animals.	Number and Amount of Feedings.	Killed or Died. No. of Days.	Post-mortem Examination and Remarks.
1 guinea-pig	15 feedings=150 cc.	Killed 98	Nil.
1 do.	Do.	Killed 98	Nil.
1 do.	Do.	Killed 148	Nil. Peyer's patches were apparently enlarged. Microscopic examination showed no evidence of tubercle but rod shaped organisms and cocci were present.
3			

Injection Experiments.

No. of Animals.	Time Sterilised.	Intraperitoneal Injection.	Killed or Died. No. of Days.	Post-mortem Examination and Remarks.
1 guinea-pig	**15** minutes	1 cc.	Died 13	Too early to show tuberculosis.
1 do.	Do.	1 cc.	Killed 53	Nil.
1 do.	Do.	1 cc.	Killed 98	Nil.
3				
1 guinea-pig	**30** minutes	1 cc.	Killed 98	Nil.
1 do.	Do.	1 cc.	Killed 98	Nil.
1 do.	Do.	1 cc.	Killed 148	Nil.
3				
1 guinea-pig	**60** minutes	1 cc.	Killed 98	Nil.
1 do.	Do.	1 cc.	Killed 98	Nil.
1 do.	Do.	1 cc.	Killed 148	Nil.
3				

Control Injection Experiments with Raw Milk.

No. of Animals.	Intraperitoneal Injection.	Killed or Died. No. of Days.	Post-mortem Examination and Remarks.
1 guinea-pig	1 cc.	Died 38	**Tubercular.** On the wall of the abdomen well-marked caseous tubercles were seen; mesenteric lymphatic system and mesenteric glands also affected; spleen, liver, and pancreas markedly tubercular; beautiful tubercles on the diaphragm following the course of the lymphatics and on the serous covering of the ribs; bronchial and posterior mediastinal glands tubercular; lungs with only early tubercle; pleural cavity full of fluid. Microscopic examination, tubercle bacilli found.
1 do.	1 cc.	Died 57	**Tubercular.** Similar to the foregoing. Microscopic examination, tubercle bacilli found.
1 do.	1 cc.	Killed 98	**Tubercular.** Spleen, liver, and pancreas enormously enlarged and tubercular; lungs and bronchial glands markedly affected retro-peritoneal, mediastinal, anterior, and posterior mediastinal glands, and glands in the neck all enlarged and tubercular.
3			

PART XIII.

Details of feeding and injection experiments made with milk to which manifestly tuberculous material had been added, heated at various temperatures:—

Table CIII., heated at 50° C. (122° F.), p. 230.
Table CIV., heated at 55° C. (131° F.), p. 238.
Table CV., heated at 60° C. (140° F.), p. 243.
Table CVI., heated at 65° C. (149° F.), p. 252.
Table CVII., heated at 70° C. (158° F.), p. 262.
Table CVIII., heated at 75° C. (167° F.), p. 270.
Table CIX., heated at 80° C. (176° F.), p. 274.
Table CX., heated at 85° C. (185° F.), p. 277.
Table CXI., heated at 90° C. (194° F.), p. 279.

In these, as in the previous Tables, the records of the experiments with heated artificial tubercular milk are placed on the left side of the page, the control experiments on the right. The two halves of the Table are identical, except that in the part on the left, in the second column, is given the time during which the milk was kept at any given temperature; the other four columns are alike in each half. In the first the number and species of the animals used are given; one of the other columns in each is devoted to the number of feedings or injections, the numbers of the materials used, and the total amount given in each case. In the next column is given the time in days at which the animal died or was killed after the commencement of the experiment, and in the last column are given the results of the post-mortem examinations, and any notes or remarks on the cases.

PART XIII.

TABLE CIII.

Experiments with Milk to which manifestly Tuberculous Material had been added, exposed to a Temperature of 50° C. (122° F.)

Materials used.

1. Spleen, liver, and glands of tubercular guinea-pigs + sound milk.
   Control experiments, **Injection, 3** guinea-pigs, **2 tubercular,** 1 died too early to show tubercle.
2. Tubercular milk from Cow No. 25.
   Control experiments { **Injection, 3** guinea-pigs, **2 tubercular,** 1 killed too early to show tubercle.
   Feeding, 3 guinea-pigs, **2 tubercular,** 1 died too early to show tubercle.
3. Tubercular lung from Cow No. 23 + organs of two tubercular guinea-pigs + sound milk.
4. Tubercular lung from Cow No. 18 + sound milk.
5. Tubercular lung from cow received from Metropolitan Cattle Market.
   Control experiments { **Injection, 3** guinea-pigs, **3 tubercular.**
   Feeding, 3 guinea-pigs, **3 tubercular.**

Feeding Experiments with Milk to which manifestly Tubercular Material had been added and Heated at 50° C. (122° F.).					**Control Feeding Experiments.**			
No. of Animals.	Time Sterilised.	Number and Amount of Feedings.	Killed or Died. No. of Days.	Post-mortem Examination and Remarks.	No. of Animals.	Number and Amount of Feedings.	Killed or Died. No. of Days.	Post-mortem Examination and Remarks.
1 guinea-pig -	**1** hour - -	1, 2, 3, 4 = 195 cc. -	Died 161 -	**Tubercular.** Mesenteric glands much enlarged, yellow in centre, tubercular; liver and spleen both contain large white nodules, firm and fibrous on section; ulceration at several points in the lower part of the large intestine; other organs normal. Microscopic examination, tubercle bacilli found.	1 guinea-pig -	1 = 25 cc. - -	Died 20 - -	Too early to show tubercle.
					1 do. -	Do. - - -	Killed 62 -	Nil.
					2			
1 do. -	Do. - -	Do. do. - -	Died 123 -	**Tubercular.** Mesocolic, cæcal, mesenteric, and cœliac glands, enlarged, and caseous; the spleen contained a few tubercle nodules; in the liver the tubercle is more advanced; ulceration of both large and small intestines; tubercle had extended directly through the posterior part of the diaphragm to the lungs; mediastinal and bronchial glands also affected. Microscopic examination, tubercle bacilli found.				
					1 guinea-pig -	1, 2, 3 = 375 cc. - -	Killed 125 -	**Tubercular.** Tubercle of spleen, liver, and pancreas; mesocolic, mesenteric, cœliac glands, and glands at hilus of liver, all tubercular; tubercular ulceration of the intestine; mediastinal and bronchial glands enlarged and tubercular; early tubercle of the lungs. Microscopic examination, tubercle bacilli found.
1 do. - 3	Do. - -	Do. do. - -	Killed 161 -	**Tubercular.** Very similar to No. 1 of this set, but more advanced; ulceration of cæcum; early tubercle in colon, well marked tubercle in the ilium; pancreas and lungs also affected. Microscopic examination, tubercle bacilli found.		Control experiments for No. 2 Material, *see* Table CIV., pp. 238 and 240.		

TABLE CIII—*continued.*

Feeding Experiments with Milk to which manifestly Tubercular Material had been added, Heated at 50° C. (122° F.)—*cont.*

No. of Animals.	Time Sterilised.	Number and Amount of Feedings.	Killed or Died. No. of Days.	Post-mortem Examination and Remarks.
1 guinea-pig	**2** hours	1 = 30 cc.	Died 52	Nil.
1 do.	Do.	1, 2, 3, 4 = 280 cc.	Died 167	**Tubercular.** Mesenteric glands enlarged and indurated; tubercular nodules in, and ulceration of, the mucous membrane of the intestine. Microscopic examination, tubercle bacilli found.
1 do.	Do.	Do. do.	Killed 172	**Tubercular.** Three large, firm, white fibrous nodules in the spleen; several minute white points in the liver; mesenteric glands enormously enlarged, almost cartilaginous; the glands attached to the cæcum are specially affected; several white or greyish nodules in the lung, but glands at root unaffected. Microscopic examination, tubercle bacilli found.
3				
1 kitten	**2** hours	5 = 100 cc.	Died 33	Nil.
1 kitten	**3** hours	5 = 100 cc.	Died 57	**Tubercular.** Both lungs and posterior mediatinal and bronchial glands tubercular. In the lungs are large, yellow, caseo-purulent areas or masses ¾″ in diameter, involving half of the left lung and three-quarters of the right; no tubercle of the intestine or of any abdominal organ; this kitten was fed with a spoon; it is probable that infection was due to inhalation of some of the fluid meant to be swallowed. Microscopic examination. Tubercle bacilli found.
1 guinea-pig	**3** hours	5 = 100 cc.	Died 33	Nil.
1 do.	Do.	Do.	Died 35	Nil.
1 do.	Do.	Do.	Killed 62	**Tubercular.** Spleen distinctly affected. In the liver are a few small miliary tubercles. Peyers patches in the intestine are tubercular, as are also the mesenteric glands. Microscopic examination, tubercle bacilli found.
3				
1 guinea-pig	**4** hours	5 = 100 cc.	Died 33	Nil. Peculiar nerotic patches in liver, but no tubercle.
1 do.	Do.	Do.	Killed 61	**Tubercular.** Mesenteric glands slightly enlarged, one considerably affected.
1 do.	Do.	Do.	Killed 61	**Tubercular.** Peyers patch only affected.
3				
1 kitten	**4** hours	5 = 100 cc.	Died 50	Nil.
1 cat	Do.	Do.	Killed 62	Nil.
2				

Control Feeding Experiments—*cont.*

No. of Animals.	Number and Amount of Feedings.	Killed or Died. No. of Days.	Post-mortem Examination and Remarks.
1 guinea-pig	5 = 33 cc.	Died 23	**Tubercular.** Early tubercle of the spleen and liver; mesenteric and mesocolic glands enlarged; tubercular ulceration of the intestine. Microscopic examination, tubercle bacilli found.
1 do.	Do.	Died 59	**Tubercular.** Large tubercular caseous nodules in the spleen, which is much enlarged; liver, mesenteric glands, and intestines distinctly tubercular—in the latter there is well-marked ulceration; bronchial and mediastinal glands and lungs all tubercular. Microscopic examination, tubercular bacilli found.
1 do.	Do.	Killed 61	**Tubercular.** Similar to the above, but in a much more advanced condition; glands in the neck slightly enlarged; most extensive and advanced tubercle, with well-marked ulceration in both large and small intestines. Microscopic examination, tubercle bacilli found.
3			

TABLE CIII.—*continued.*

Feeding Experiments with Milk to which manifestly Tubercular Material had been added, Heated at 50° C. (122° F.)—*cont.*

Control Feeding Experiments.—*cont.*

No. of Animals.	Time Sterilised.	Number and Amount of Feedings.	Killed or Died. No. of Days.	Post-mortem Examination and Remarks.	No. of Animals.	Number and Amount of Feedings.	Killed or Died. No. of Days.	Post-mortem Examination and Remarks.
1 guinea pig	**4** hours	1, 2, 3, 4 = 200 cc.	Died 165	**Tubercular.** Early tubercle of the liver; mesenteric and mesocolic glands enlarged, caseating; two tubercular nodules, not yet ulcerated, in the large intestine; one or two early tubercular points in the lungs. Microscopic examination, tubercle bacilli found.				
1 do.	Do.	Do.	Killed 172	**Tubercular.** Three large, firm, fibrous, white nodules in the spleen; well marked tubercle in the liver; mesenteric glands greatly enlarged and hardened, especially those attached to the cæcum; numerous light grey nodules in the lungs; glands at root somewhat enlarged, but not distinctly tubercular.				
1 do.	Do.	Do.	Killed 172	**Tubercular.** Very similar to the above. Microscopic examination, tubercle bacilli found.				
3								
1 guinea pig	**5** hours	5 = 100 cc.	Died 22	Nil.				
1 do.	Do.	Do.	Killed 62	Nil.				
1 do.	Do.	Do.	Killed 62	Nil.				
3								
1 guinea-pig	**6** hours	5 = 100 cc.	Died 48	Nil.				
1 do.	Do.	Do.	Killed 61	Nil. Swollen and opaque glands in small intestine, but these are not tubercular.				
1 do.	Do.	Do.	Killed 61	Nil.				
3								
1 guinea pig	**7** hours	5 = 100 cc.	Died 47	Nil. Mesenteric gland somewhat enlarged. Microscopic examination, structure quite normal.				
1 do.	Do.	Do.	Died 53	Nil. Localised patches of scar-like tissue, mottled red and yellow, which somewhat resembles tubercular tissue. Microscopic examination, no tubercle bacilli could be found, but diplococci and short rods, which were stained blue, were somewhat numerous. It is impossible to say that this was not a case of tuberculosis, but the evidence was confined to structural appearances and caseation, as no tubercle bacilli could be found.				
1 do.	Do.	Do.	Killed 62	Nil. Mesenteric glands slightly enlarged, but not tubercular.				
3								

TABLE CIII.—*continued.*

Feeding Experiments with Milk to which manifestly Tubercular Material had been added, Heated at 50° C. (122° F.)—*cont.*					Control Feeding Experiments—*cont.*			
No. of Animals.	Time Sterilised.	Number and Amount of Feedings.	Killed or Died. No. of Days.	Post-mortem Examination and Remarks.	No. of Animals.	Number and Amount of Feedings.	Killed or Died. No. of Days.	Post-mortem Examination and Remarks.
1 guinea-pig -	**8** hours - -	1, 3, 4 = 162 cc. - -	Died 144 - -	Nil.				
1 do. -	Do. - -	Do. - -	Died 144 - -	Nil.				
1 do. -	Do. - -	Do. - -	Killed 174 -	Nil.				
3								
1 guinea-pig -	**12** hours - -	1 = 30 cc. - -	Died 4 - -	Too early to show tuberculosis.				
1 do. -	Do. - -	1, 2, 3 = 180 cc. - -	Died 66 - -	Nil. Bloody serum in the peritoneal cavity, great œdema of the subcutaneous tissue. Bile stained patches in liver.				
1 do. -	Do. - -	1, 2, 3, 4 = 380 cc. -	Killed 174 -	Nil.				
3								
1 guinea-pig -	**24** hours - -	1, 2, 3, 4 = 200 cc. - -	Killed 138 -	Nil.				
1 do. -	Do. - -	Do - -	Killed 174 -	Nil. Parasitic growths, one in spleen and several in lung. Microscopic examination showed no evidence of tubercle.				
1 do. -	Do. - -	Do. - -	Killed 17 -	Nil.				
3								
1 guinea-pig -	**48** hours - -	2, 3 = 130 cc. - -	Died 29 - -	Nil. A single parasitic nodule seen in the spleen. Mesenteric glands slightly enlarged. Microscopic examination showed no trace of tubercle.				
1 do. -	Do. - -	2, 3, 4 = 230 cc. - -	Killed 129 -	Nil.				
1 do. -	Do. - -	Do. - -	Killed 129 -	Nil.				
3								

TABLE CIII.—*continued.*

Injection Experiments with Milk to which manifestly Tubercular Material had been added, Heated at 50° C. (122° F.)

No. of Animals.	Time Sterilised.	Intraperitoneal Injection.	Killed or Died. No. of Days.	Post-mortem Examination and Remarks.
1 guinea-pig	1 hour	1 = 1½ cc.	Killed 46	**Tubercular.** Wall of abdomen, especially the diaphragm, covered with miliary tubercles; spleen not much enlarged but tubercular, as is also the liver; mesenteric glands enlarged, caseous, tubercular; early tubercular nodules in the lungs. Microscopic examination, numerous tubercle bacilli found.
1 do.	Do.	1 = 1½ cc.	Killed 46	**Tubercular.** Very similar to above. Microscopic examination, numerous tubercle bacilli found.
1 do.	Do.	1, 2 = 6½ cc.	Died 63	**Tubercular.** Peritoneal cavity filled with clear fluid, walls studded with tubercular points; well marked tubercle of the spleen, liver, and pancreas; early tubercle of the lungs. Microscopic examination, tubercle bacilli found.
1 do.	Do.	Do.	Died 74	**Tubercular.** Very similar to above, but in addition "grapes" were found on the ribs. Microscopic examination, tubercle bacilli found.
4				
1 guinea-pig	2 hours	1 = 1½ cc.	Killed 46	**Tubercular.** Peritoneal covering of abdominal wall covered with tubercular nodules; tubercle of the diaphragm, spleen, and liver; mesenteric glands enlarged, caseous; early tubercle of the lung and of the glands in the posterior mediastinum. Microscopic examination, tubercle bacilli found.
1 do.	Do.	Do.	Killed 48	**Tubercular.** Very similar to the above, but the pancreas is also affected. Microscopic examination, numerous tubercle bacilli found in sections of this pancreas.
1 do.	Do.	1, 2 = 6½ cc.	Died 63	**Tubercular.** Very similar to the above, but the abdominal cavity is filled with slightly blood-stained fluid. Microscopic examination, tubercle bacilli found.
1 do.	Do.	Do.	Killed	**Tubercular.** Abscess in wall of abdomen; early tubercle of the liver in the form of scattered points; glands in the hilus of liver enlarged and indurated. Spleen and pancreas enlarged and studded with tubercular nodules; early tubercle of the mediastinal and bronchial glands, and in the substance of the lungs. Microscopic examination, tubercle bacilli found.
4				

Control Injection Experiments.

No. of Animals.	Intraperitoneal Injection.	Killed or Died. No. of Days.	Post-mortem Examination and Remarks.
1 guinea-pig	1 = 1½ cc.	Died 5	Too early to show tubercle.
1 do.	Do.	Died 26	**Tubercular.** Peritoneal covering of the abdominal wall and diaphragm studded with tubercular granulations; spleen and liver both distinctly tubercular. On microscopic examination tubercle bacilli were found.
1 do.	Do.	Died 50	**Tubercular.** Very similar to the above, but the liver was not affected. On microscopic examination very large numbers of tubercle bacilli were found in the spleen.
3			
	Control Experiments for No. 2 Material, *see* Table, CI., p. 226.		
1 guinea-pig	5 = 1 cc.	Killed 40	**Tubercular.** Wound still open, edges indurated, a dry scab covering part of the surface; beneath and around this scab a purulent discharge was escaping; spleen, liver, cœliac, and deep inguinal glands enlarged and studded with tubercle nodules, the inguinal gland also containing pus; the glands behind the sternum were enlarged yellow, cheesy; no other tubercle in the thorax or elsewhere. Microscopic examination, tubercle bacilli found.
1 do.	Do.	Killed 40	**Tubercular.** Very similar to the above. Microscopic examination, tubercle bacilli found.
1 do.	Do.	Died 16	**Tubercular.** Showed thickening at the seat of inoculation, where an abscess containing cheesy pus had formed. Microscopic examination, tubercle bacilli found.

TABLE CIII.—*continued.*

Injection Experiments with Milk to which manifestly Tubercular Material had been added, Heated at 50° C. (122° F.)—*cont.*

Control Injection Experiments—*cont.*

No. of Animals.	Time Sterilised.	Intraperitoneal Injection.	Killed or Died. No. of Days.	Post-mortem Examination and Remarks.	No. of Animals.	Intraperitoneal Injection.	Killed or Died. No. of Days.	Post-mortem Examination or Remarks.
1 kitten	3 hours	5 = 1 cc.	Died 33	**Tubercular.** Beautiful tubercular granulations on the peritoneum, in the lymphatics of the diaphragm, in the serous coverings of all the abdominal organs, and in the substance of the liver; mesenteric, mesocolic, and cœliac glands, and those at the hilus of liver all tubercular. None elsewhere. Microscopic examination, tubercle bacilli found.				
1 guinea-pig	4 hours	1 = 1½ cc.	Died 28	**Tubercular.** Early tubercle nodules in the spleen and pancreas, but none elsewhere.				
1 do.	Do.	Do.	Died 31	**Tubercular.** Tubercular points at the seat of inoculation, and in the peritoneal covering of the abdominal wall around this, also in the omentum, and in the mesenteric glands, spleen, liver, and pancreas; none elsewhere. Microscopic examination, tubercle bacilli found.				
1 do.	Do.	1, 2 = 6½ cc.	Died 66	**Tubercular.** Serous cavities filled with fluid; advanced tubercle of the spleen, liver, and pancreas; slight affection of the mesenteric glands; advanced tuberculosis of the mediastinal and bronchial glands and of the lungs. Microscopic examination, numerous tubercle bacilli found.				
1 do. 4	Do.	Do.	Died 87	**Tubercular.** Very similar to the above, but more advanced in the mesenteric system. Microscopic examination, numerous tubercle bacilli found.				
1 kitten	6 hours	5 = 1 cc.	Died 53	**Tubercular.** Tubercle nodules in the wall of the abdomen, and in the diaphragm. A number of raised tubercular nodules in the pancreas, mesenteric glands enlarged, and full of firm cheesy pus; whole mesentery covered with grey miliary tubercles; deep inguinal and cœliac glands all enlarged. Microscopic examination, tubercle bacilli found.				

TABLE CIII.—*continued.*

Injection Experiments with Milk to which manifestly Tubercular Material had been added, Heated at 50° C. (122° F.)—*cont.*

Control Injection Experiments—*cont.*

No. of Animals.	Time Sterilised.	Intraperitoneal Injection.	Killed or Died. No. of Days.	Post-mortem Examination and Remarks.	No. of Animals.	Intraperitoneal Injection.	Killed or Died. No. of Days.	Post-mortem Examination and Remarks.
1 guinea-pig	**8** hours	1 = 1½ cc.	Died 61	Nil.				
1 do.	Do.	Do.	Killed 104	Nil.				
1 do.	Do.	Do.	Killed 117	**Tubercular.** Gland at the hilus of the liver large, hard and yellow; at one part it is fatty, but there is a single opaque yellow point in which tubercle bacilli were found. On microscopic examination this point resembled those sometimes met with in cats fed on tubercular milk except that here there was no calcification.'				
1 do.	Do.	Do.	Killed 118	Nil.				
4								
1 guinea-pig	**12** hours	1, 2 = 7½ cc.	Died 73	Nil.				
1 do.	Do.	Do.	Died 117	**Tubercular.** Tubercle nodules at and around the seat of inoculation; spleen, liver, and pancreas markedly affected; all the glands in the abdominal cavity enlarged, most of them filled with cheesy pus; gelatinous tubercular points in the lung; glands in the neck enlarged and cheesy. Microscopic examination, tubercle bacilli found.				
1 do.	Do.	Do.	Killed 117	**Tubercular.** Similar to above case, but not so advanced.				
1 do.	Do.	Do.	Killed 117	**Tubercular.** Similar to second animal of this set. Microscopic examination, tubercle bacilli found.				
4								
1 kitten	**12** hours	5 = 1 cc.	Died 60	Nil. Lungs showed some pneumonia.				
1 guinea-pig	**12** hours	5 = 1 cc.	Died 34	Nil.				
1 do.	Do.	Do.	Killed 61	Nil.				
1 do.	Do.	Do.	Killed 61	Nil.				
3								
1 kitten	**15** hours	5 = 1 cc.	Killed 61	Nil.				

TABLE CIII.—*continued.*

Injection Experiments with Milk to which manifestly Tubercular Material had been added, Heated at 50° C.—*cont.*

Control Injection Experiments.—*cont.*

No. of Animals.	Time Sterilised.	Intraperitoneal Injection.	Killed or Died. No. of Days.	Post-mortem Examination and Remarks.	No. of Animals.	Intraperitoneal Injection.	Killed or Died. No. of Days.	Post-mortem Examination and Remarks.
1 guinea-pig	**15** hours	5 = 1 cc.	Killed 40	Nil.				
1 do.	Do.	Do.	Killed 40	Nil. Small grey nodules in the liver. Microscopic examination, no evidence of tubercle found.				
1 do.	Do.	Do.	Died 26	Nil.				
3								
1 kitten	**18** hours	5 = 1 cc.	Died 31	Nil. Some non-tubercular pneumonia, otherwise quite normal.				
1 guinea-pig	**18** hours	5 = 1 cc.	Died 5	Too early to show tubercle.				
1 do.	Do.	Do.	Died 55	Nil. Attachment of intestine to abdominal wall, merely the result of the inoculation.				
1 do.	Do.	Do.	Killed 61	Nil.				
3								
1 guinea-pig	**21** hours	5 = 1 cc.	Died 47	Nil.				
1 do.	Do.	Do.	Killed 61	Nil.				
1 do.	Do.	Do.	Killed 61	Nil.				
3								
1 guinea-pig	**24** hours	1 = 1½ cc.	Died 17	Too early to show tuberculosis.				
1 do.	Do.	Do.	Killed 46	Nil.				
1 do.	Do.	Do.	Killed 46	Nil.				
1 do.	Do.	1, 2 = 6½ cc.	Killed 118	Nil.				
4								
1 guinea-pig	**48** hours	2 = 5 cc.	Died 91	Nil.				
1 do.	Do.	Do.	Killed 129	Nil.				
1 do.	Do.	Do.	Killed 129	Nil.				
3								

TABLE CIV.

Experiments with Milk to which manifestly tuberculous milk had been added, exposed to a temperature of 55 C. (131° F.).

Materials used.

(1.) Material, liver, spleen, and glands of tubercular guinea pigs + sound milk.
Control experiments, **Injection, 3** guinea-pigs; **2 tubercular**; 1 died too early to show tubercle.
(2.) Tubercular milk from Cow No. 25.
Control experiments { **Injection, 3** guinea-pigs; **2 tubercular**; 1 killed too early to show tubercle.
Feeding, 3 guinea-pigs; **2 tubercular**; 1 died too early to show tubercle.
(3.) Material, spleen, liver, and glands of tubercular guinea pigs + sound milk.
Control feeding experiment, **1** guinea-pig, **tubercular.**
(4.) Material, purulent material from mesenteric glands of guinea-pigs. No control experiments.
(5.) Material, tubercular sputum.
Control experiments { **Injection, 3** guinea-pigs, **3 tubercular.**
Feeding, 3 guinea-pigs, **3 tubercular.**

Feeding Experiments with Milk to which manifestly Tubercular Material had been added, Heated at 55° C. (131° F.).

No. of Animals	Time Sterilised.	Number and Amount of Feedings.	Killed or Died. No. of Days.	Post-mortem Examination and Remarks.
1 guinea-pig	**45** minutes	1, 2, 3 = 190 cc.	Killed 74	Nil. Peyers patches in cæcum and intestine somewhat prominent. Microscopic examination showed no traces of tubercle.
1 do.	Do.	1, 2, 3, 4 = 290 cc.	Died 168	**Tubercular.** Mesenteric glands and intestines very tubercular, as are also the spleen, liver, lungs, and bronchial glands. Microscopic examination, tubercle bacilli found.
1 do.	Do.	Do.	Killed 173	**Tubercular.** Mesenteric glands slightly enlarged. Microscopic examination, tubercle bacilli found.
3				
1 guinea-pig	**45** minutes	5 = 100 cc.	Died 41	Nil.
1 do.	Do.	Do.	Died 26	Nil.
1 do.	Do.	Do.	Killed 63	**Tubercular.** Mesenteric glands apparently slightly enlarged; liver, minute greyish yellow points like scar tissue; other organs normal. Microscopic examination, tubercle bacilli found.
3				
1 guinea-pig	**1** hour	5 = 100 cc.	Died 25	Too early to show tubercle; minute grey granules in the liver, other organs normal. Microscopic examination shows necrotic tissue in the grey areas in the liver.
1 do.	Do.	Do.	Died 37	**Tubercular.** Mesenteric glands slightly enlarged; early tubercle of mesocolic glands; other organs normal.
1 do.	Do.	Do.	Killed 63	Nil.
3				

Control Feeding Experiments.

No. of Animals.	Number and Amount of Feedings.	Killed or Died. No. of Days.	Post-mortem Examination and Remarks.
1 guinea-pig	1 = 25 cc.	Died 20	Too early to show tubercle.
1 do.	Do.	Killed 62	Nil.
2			
1 guinea-pig	2 = 66 cc.	Died 5	Too early to show tubercle; marked fatty degeneration of the liver.
1 do.	Do.	Killed 119	**Tubercular.** Extensive tubercle of the intestines and mesenteric glands; numerous large tubercles in the spleen; a number of fine points in the liver; lungs and bronchial glands tubercular, as are also the anterior mediastinal glands. Microscopic examination, tubercle bacilli found.
1 do.	Do.	Killed 119	**Tubercular.** Same condition as foregoing. Microscopic examination, tubercle bacilli found.
3			
1 guinea-pig	1, 2, 3 = 375 cc.	Killed 125	**Tubercular.** Tubercle of the mesenteric glands and intestines; mesocolic and cœliac glands, and glands in the hilus of the liver all affected; spleen, liver, and pancreas tubercular; early tubercle of the lung; bronchial glands enlarged. Microscopic examination, tubercle bacilli found.
1 do.	5 = 17 cc.	Died 35	**Tubercular.** Well-marked tubercular ulceration of the large and small intestines and the cæcum; mesenteric, mesocolic, and cœliac glands all affected; early tubercle of the liver and spleen; mediastinal and bronchial and cervical glands all tubercular; lungs contained only one or two nodules. Microscopic examination, tubercle bacilli found.
1 do.	Do.	Died 37	**Tubercular.** Very similar condition to foregoing, but lungs unaffected. Microscopic examination, tubercle bacilli found.
1 do.	Do.	Died 63	**Tubercular.** Very similar to foregoing, but lungs affected and cervical glands more enlarged. Microscopic examination, tubercle bacilli found.
3			

TABLE CIV.—*continued.*

Feeding Experiments with Milk to which manifestly Tubercular Material had been added, Heated at 55° C. (131° F.)—*cont.*

Control Feeding Experiments—*cont.*

No. of Animals.	Time Sterilised.	Number and Amount of Feedings.	Killed or Died. No. of Days.	Post-mortem Examination and Remarks.	No. of Animals.	Number and Amount of Feedings.	Killed or Died. No. of Days.	Post-mortem Examination and Remarks.
1 guinea-pig	**1¼** hours	5 = 100 cc.	Died 3	Too early to show tubercle.				
1 do.	Do.	Do.	Killed 63	**Tubercular.** Mesenteric glands slightly enlarged; minute greyish yellow points, like scar tissue, in the liver; other organs normal. Microscopic examination, tubercle bacilli found.				
1 do.	Do.	Do.	Killed 63	**Tubercular.** Mesenteric glands slightly enlarged; early tubercle in the Peyers patches of the intestines.				
3								
1 guinea-pig	**1½** hours	5 = 100 cc.	Died 36	Nil.				
1 do.	Do.	Do.	Died 37	Nil.				
1 do.	Do.	Do.	Killed 63	**Tubercular.** Minute greyish yellow points like scar tissue in the liver. Microscopic examination, tubercle bacilli found.				
3								
1 guinea-pig	**1½** hours	1 = 25 cc.	Died 8	Too early to show tuberculosis.				
1 do.	Do.	1, 2 = 125 cc.	Died 49	Nil.				
1 do.	Do.	1, 2, 3 = 325 cc.	Died 60	Nil.				
3								
1 guinea-pig	**3** hours	1, 2, 3, 4 = 260 cc.	Died 137	Nil.				
1 do.	Do.	Do.	Died 145	Nil.				
1 do.	Do.	Do.	Killed 175	Nil.				
3								
1 guinea-pig	**7** hours	1, 2 = 125 cc.	Died 53	Nil.				
1 do.	Do.	1, 2, 3 = 225 cc.	Died 168	Nil. Mesenteric glands apparently slightly enlarged, otherwise animal quite normal.				
1 do.	Do.	Do.	Killed 173	Nil. Similar to above.				
3								
1 guinea-pig	**10** hours	1, 2 = 125 cc.	Died 46	Nil.				
1 do.	Do.	1, 2, 3, 4 = 290 cc.	Died 159	Nil.				
1 do.	Do.	Do.	Killed 172	Nil.				
3								
1 guinea-pig	**20** hours	1, 2, 3 = 180	Died 137	Nil.				
1 do.	Do.	Do.	Killed 172	Nil.				
1 do.	Do.	Do.	Killed 172	Nil.				
3								

TABLE CIV.—*continued.*

Injection Experiments with Milk to which manifestly Tubercular Material had been added, Heated at 55° C. (131° F.) | **Control Injection Experiments.**

No. of Animals.	Time Sterilised.	Intraperitoneal Injections.	Killed or Died. No. of Days.	Post mortem Examination and Remarks.	No. of Animals.	Intraperitoneal Injections.	Killed or Died. No. of Days.	Post-mortem Examination and Remarks.
1 guinea-pig	**45** minutes	1 = 12 cc.	Died 23	**Tubercular.** Omentum, well-marked tubercle; mesenteric glands enlarged; a few nodules in the spleen; diaphragm and walls of peritoneum also affected; only early tubercle in the liver and lungs. Microscopic examination, tubercle bacilli found.	1 guinea pig	1 = 1½ cc.	Died 5	Too early to show tuberculosis.
1 do.	Do.	1, 2 = 6½ cc.	Died 55	**Tubercular.** Somewhat similar to the foregoing, but more advanced. Microscopic examination, tubercle bacilli found.	1 do.	Do.	Died 26	**Tubercular.** Well marked tubercle of the abdominal wall and diaphragm, the latter being attached to the upper surface of the liver; spleen and liver also tubercular; lungs normal. Microscopic examination, tubercle bacilli found.
1 do.	Do.	Do.	Died 67	**Tubercular.** Mesenteric glands slightly enlarged; pancreas, spleen, liver, lungs, and bronchial glands all tubercular; pleural cavity filled with serous fluid. Microscopic examination, tubercle bacilli found.	1 do.	Do.	Died 50	**Tubercular.** More advanced condition than the above, but liver not attached to the diaphragm. Microscopic examination, numerous tubercle bacilli found.
1 do.	Do.	Do.	Died 67	**Tubercular.** More advanced condition than the foregoing. Microscopic examination, tubercle bacilli found.	3			
4								
1 guinea-pig	**1½** hours	1 = 1½ cc.	Died 10	Too early to show tuberculosis.				
1 do.	Do.	Do.	Died 13	Do.				
1 do.	Do.	Do.	Died 22	**Tubercular.** Distinct early tubercles in the spleen and early points of tubercle over the surface of the liver; other organs normal. Microscopic examination, tubercle bacilli found.				
1 do.	Do.	1, 2 = 6½ cc.	Died 97	**Tubercular.** Spleen and pancreas markedly tubercular; tubercle not so advanced in the liver; early tubercle of the lungs; pleural cavity filled with serous fluid. Microscopic examination, tubercle bacilli found.	1 guinea-pig	2 = 1 cc.	Killed 13	Too early to show tubercle.
4					1 do.	Do.	Died 33	**Tubercular.** Well-marked tubercle over the wall of the abdomen and mesenteric system; many fine tubercular points in the liver; spleen tubercular but not nodular; early tubercle of the lungs; bronchial glands enlarged but not yet caseous or purulent; pleural and abdominal cavities filled with serous fluid. Microscopic examination, tubercle bacilli found.
1 guinea-pig	**3** hours	1 = 1½ cc.	Died 5	Too early to show tuberculosis.	1 do.	Do.	Died 40	**Tubercular.** Tubercle well marked in spleen and liver, the former being much enlarged; the pancreas and abdominal wall also affected; lungs and glands behind the sternum, tubercular. Microscopic examination, tubercle bacilli found.
1 do.	Do.	1, 2, 3 = 11½ cc.	Died 81	**Tubercular.** Abdominal cavity filled with purulent fluid; one large tubercle nodule and a number of smaller ones in the spleen; early tubercle of the liver; lungs, normal. Microscopic examination, tubercle bacilli found.	3			
1 do.	Do.	Do.	Died 97	**Tubercular.** Spleen markedly affected; pancreas slightly tubercular; very fine miliary tubercles studding the surface of the liver; lungs and bronchial glands only slightly affected; pleural cavity filled with serous fluid. Microscopic examination, tubercle bacilli found.				
1 do.	Do.	Do.	Died 97	**Tubercular.** Spleen and pancreas markedly tubercular; mesenteric glands enlarged; numerous medium-sized tubercle patches in the liver; several early points in the lungs; bronchial glands slightly enlarged; pleural cavity filled with serous fluid. Microscopic examination, numerous tubercle bacilli found.				
4								

TABLE CIV.—*continued.*

Injection Experiments with Milk to which manifestly Tubercular Material had been added, Heated at 55° C. (131° F.)—*cont.*

No. of Animals.	Time Sterilised.	Intraperitoneal Injections.	Killed or Died. No. of Days.	Post-mortem Examination and Remarks.
1 guinea-pig	**3** hours	5 = 1 cc.	Died 38	**Tubercular.** Spleen tubercular; doubtful tubercle of the liver; cœliac, mesenteric and retroperitoneal glands, glands in hilus of kidney, deep inguinal and pelvic glands all tubercular; lungs congested but not tubercular. Microscopic examination, tubercle bacilli found.
1 do.	Do.	Do.	Died 24	Nil.
1 do.	Do.	Do.	Killed 63	**Tubercular.** Spleen tubercular; liver adhering to under surface of diaphragm markedly tubercular; mesenteric, mesocolic glands, glands at hilus of liver, cœliac, poststernal and bronchial glands all tubercular; lungs, normal. Microscopic examination, tubercle bacilli found.
3				
1 guinea-pig	**4** hours	5 = 1 cc.	Killed 63	**Tubercular.** Only early tubercle of mesentery.
1 do.	Do.	Do.	Killed 63	**Tubercular.** Same as the foregoing. Microscopic examination, tubercle bacilli found.
1 do.	Do.	Do.	Killed 63	**Tubercular.** Same as the foregoing.
3				
1 guinea-pig	**5** hours	5 = 1 cc.	Died 36	Nil.
1 do.	Do.	Do.	Killed 63	Nil.
1 do.	Do.	Do.	Killed 63	Nil.
3				
1 guinea-pig	**6** hours	5 = 1 cc.	Died 25	Nil.
1 do.	Do.	Do.	Died 28	**Tubercular** at the point of injection only.
1 do.	Do.	Do.	Died 36	**Tubercular.** Cheesy pus at the seat of injection; spleen normal; mesenteric glands slightly enlarged; some parasitic-looking nodules in the liver; other organs normal. Microscopic examination, tubercle bacilli found in the pus.
3				
1 guinea-pig	**7** hours	1 = 1½ cc.	Died 22	Nil. One or two nodular-looking points in spleen and pancreas. Microscopic examination gave no evidence of tuberculosis.
1 do.	Do.	1, 2 = 6½ cc.	Killed 43	Nil.
1 do.	Do.	Do.	Killed 43	Nil. Mesenteric glands apparently slightly enlarged. Microscopic examination showed small necrotic areas in which are seen a number of cocci, but no tubercle bacilli.
1 do.	Do.	Do.	Killed 105	Nil.
4				

Control Injection Experiments—*cont.*

No. of Animals.	Intraperitoneal Injections.	Killed or Died. No. of Days.	Post-mortem Examination and Remarks.
1 guinea-pig	5 = 1 cc.	Died 31	**Tubercular.** Well-marked tubercles over the abdominal walls; mesenteric glands slightly enlarged and tubercular; liver and spleen manifestly affected; early tubercle of the lungs and mediastinal glands. Microscopic examination, tubercle bacilli found.
1 do.	Do.	Killed 42	**Tubercular.** Very similar condition to foregoing. Microscopic examination, tubercle bacilli found.
1 do.	Do.	Killed 42	**Tubercular** Similar to foregoing. Microscopic examination, tuberclo bacilli found.
3			

TABLE CIV.—*continued.*

Injection Experiments with Milk to which manifestly Tubercular Material had been added, Heated at 55° C. (131° F.)—*cont.*

Control Injection Experiments—*cont.*

No. of Animals.	Time Sterilised.	Intraperitoneal Injections.	Killed or Died. No. of Days.	Post-mortem Examination and Remarks.	No. of Animals.	Intraperitoneal Injections.	Killed or Died. No. of Days.	Post-mortem Examination and Remarks.
1 guinea-pig	**10** hours	1 = 1⅓ cc.	Died 12	Too early to show tubercle.				
1 do.	Do.	Do.	Died 17	Do				
1 do.	Do.	Do.	Died 1	Do.				
1 do.	Do.	1, 2, 3 = 11⅓ cc.	Killed 105	Nil. Fatty white patch in liver. Microscopic examination showed fatty degeneration of the liver cells and slight increase in the number of nuclei.				
4								
1 guinea-pig	**20** hours	1, 2 = 6½ cc.	Died 145	Nil.				
1 do.	Do.	Do.	Killed 173	Nil. Parasitic, white, irregular patch on the surface of the liver. Microscopic examination showed cocci, but no tubercle bacilli or tubercular structure.				
1 do.	Do.	Do.	Killed 173	Nil.				
1 do.	Do.	Do.	Killed 173	Nil.				
4								

TABLE CV.

Experiments with Milk to which Manifestly Tuberculous Material had been added, exposed to a Temperature of 60° C. (140° F.)

Materials used.

(1.) Tubercular lung of cow + sound milk.
Control experiments { **Feeding, 3** guinea pigs, 3 nil.
Injection, 3 guinea pigs, **2 tubercular,** 1 nil; **1 Cat tubercular.**

(1*a*.) Tubercular organs from guinea pigs + sound milk.
Control experiments.—**Injection, 3** guinea pigs, **3 tubercular.**

(2.) Tubercular organs from guinea pigs + sound milk.

(3.) Milk from Cow No. 27.
This milk may be left out of account, as it was proved to be non-tubercular.

(4.) Tubercular milk from Cow No. 25 + sound milk.
Control experiments { **Feeding, 3** guinea pigs, **2 tubercular,** 1 died too early to show tubercle.
Injection, 3 guinea pigs, **3 tubercular.**

(5.) Tubercular milk from Cow No. 25, + tubercular organs and glands of guinea pigs + sound milk.
Control experiments.—**Injection, 3** guinea pigs, **2 tubercular,** 1 died too early to show tubercle.

(6.) Tubercular spleen, lung, liver, and glands of pig and guinea pigs + sound milk.
Control experiments.—**Injection, 3** guinea pigs, **2 tubercular,** 1 died too early to show tubercle.

(7.) Tubercular organs of guinea pigs + sound milk.

(8.) Tubercular organs of guinea pigs + grapes from Metropolitan Cattle Market + sound milk.
Control experiments.—**Injection, 3** guinea pigs, **3 tubercular.**

(9.) Tubercular organs of guinea pigs + sound milk.
Control experiments.—All died too early to show tuberculosis.

(10.) Tubercular, human, lung + sound milk.
Control experiments.—**Feeding, 3** guinea pigs, **1 tubercular,** 1 nil, 1 died too early to show tubercle; **1 cat tubercular.**

(11.) Tubercular lung of Cow, No. 33, + sound milk.
Control experiments.—**Feeding, 1 pig tubercular.**

(12.) Same material as above.

(13.) Tubercular human lung + sound milk.
Control experiments.—**Feeding, 3** guinea pigs, **2 tubercular,** 1 died too early to show tubercle.

(14.) Tubercular cow lung received from the Metropolitan Cattle Market.
Control experiments—**Injection, 3** guinea pigs, **3 tubercular.**

Feeding Experiments with Milk to which manifestly Tubercular Material had been added. Milk heated at 60° C. (140° F.)

No. of Animals.	Time Heated.	Number of Feedings and Amount.	Killed or Died. No. of Days.	Post-mortem Examination and Remarks.
1 guinea-pig	**5** minutes	1, 2, 3, 4, 5 = 250 cc.	Killed 124	Nil.
1 do.	Do.	1, 2, 3, 4, 5, 6, 7, 8, 9, 10 = 1,200 cc.	Killed 261	Nil.
1 do.	Do.	Do.	Killed 261	Nil.
3				
1 guinea-pig	**10** minutes	1, 2, 3, 4, 5, 6, 7, 8, 9, 10 = 878 cc.	Died 196	Nil.
1 do.	Do.	Do.	Died 217	**Tubercular.** Mottled cirrhotic appearance of liver; patches of yellow, mottled with grey and crimson streak. Microscopic examination shows a peculiar degenerative condition of the liver cells which are fatty and atrophied. There is an increase of interlobular tissue in the form of numerous rounded cells, with here and there strands of well-developed fibrous tissue. In these new bands the small bile ducts appear to be increased in number; there are also small necrotic areas which, from a comparison with undoubtedly tubercular nodules in other cases, are thought to be tubercular, though no tubercle bacilli can be demonstrated.
1 do.	Do.	Do.	Died 217	Nil.
3				

Control Feeding Experiments.

No. of Animals.	Number of Feedings and Amount.	Killed or Died. No. of Days.	Post-mortem Examination and Remarks.
1 guinea-pig	1 = 50 cc.	Died 72	Nil.
1 do.	Do.	Died 86	Nil.
1 do.	Do.	Died 130	Nil.
3			
1 guinea-pig	1, 3, 4, 5, 7, 8 = 280cc.	Died 182	**Tubercular.** Several well marked tubercle nodules in the spleen; early tubercle of the liver; one of the mesenteric glands is very much enlarged, firm and nodular; tubercular ulceration of the large intestine, and of the lower part of the ileum; several well marked tubercle nodules in the lungs. Microscopic examination, tubercle bacilli found.
1 do.	Do.	Died 187	**Tubercular.** In a very similar condition, but the mesenteric glands are more extensively affected. Microscopic examination, tubercle bacilli found.
1 do.	Do.	Died 211	**Tubercular.** Very similar condition to that found in the first animal of this set, except that the ulceration in the intestine is confined to the cæcum. Microscopic examination, tubercle bacilli found.
3			

TABLE CV.—*continued.*

Feeding Experiments with Milk to which manifestly Tubercular Material had been added, Heated at 60° C. (140 F.)—*cont.*

No. of Animals.	Time Heated.	Number of Feedings and Amount.	Killed or Died. No. of Days.	Post-mortem Examination and Remarks.
1 guinea-pig	**15** minutes	1 = 50 cc.	Died 33	Nil.
1 do.	Do.	1, 2, 3, 4, 5 = 350 cc.	Died 147	Nil.
1 do.	Do.	1, 2, 3, 4, 5, 6, 7, 8 = 1,000 cc.	Killed 261	Nil.
3				
1 guinea-pig	**15** minutes	1, 2, 3, 4, 5, 6, 7, 8, 9, 10 = 878 cc.	Died 176	Nil.
1 do.	Do.	Do.	Died 181	Nil.
1 do.	Do.	Do.	Died 210	Nil.
3				
1 cat	**15** minutes	12, 13 = 1,100 cc.	Killed 89	Nil.
1 guinea-pig	**20** minutes	8, 9, 10 = 340 cc.	Died 24	Nil.
1 do.	Do.	Do.	Killed 143	Nil.
1 do.	Do.	Do.	Killed 143	**Tubercular.** White patches on the anterior surfaces of both lobes of the liver, the so-called cicatricial tissue; cœliac glands somewhat enlarged; other organs normal. Microscopic examination showed a very similar condition to that found in the second animal fed with milk sterilised for 10 minutes, as described above.
3				
1 guinea-pig	**25** minutes	1, 2, 3, 4, 5, 6, 7 = 450 cc.	Died 208	Nil.
1 do.	Do.	Do.	Died 204	Nil.
1 do.	Do.	Do.	Killed 255	Nil.
3				
1 guinea-pig	**30** minutes	1, 2, 3, 4, 5, 7, 8, 9 = 830 cc.	Killed 205	Nil.
1 do.	Do.	Do.	Killed 195	Nil.
1 do.	Do.	Do.	Killed 249	Nil.
3				

Control Feeding Experiments—*cont.*

No. of Animals.	Number of Feedings and Amount.	Killed or Died. No. of Days.	Post-mortem Examination and Remarks.
1 guinea-pig	1*a*, 3, 4 = 140 cc.	Died 142	**Tubercular.** Only a couple of tubercle nodules in the spleen, otherwise perfectly normal. Microscopic examination, tubercle bacilli found.
1 do.	1*a*, 3, 4, 5, 7, 8 = 390 cc.	Died 184	**Tubercular.** Tubercle of one of the mesocolic glands; small nodules in the intestine; other organs normal. Microscopic examination, tubercle bacilli found.
1 do.	Do.	Killed 241	**Tubercular.** Spleen not much enlarged, but contains several tubercle nodules. A few scattered patches in the liver; mesenteric glands and glands at hilus of liver enlarged, the former enormously so, with firm shell containing soft cheesy pus; well marked tubercular ulceration of the small intestine and cæcum; mediastinal and bronchial glands enlarged and tubercular, but the lungs have only one or two small tubercular points scattered over their surface. Microscopic examination, tubercle bacilli found.
3			
1 guinea-pig	4 = 66 cc.	Died 5	Too early to show tubercle.
1 do.	Do.	Killed 119	**Tubercular.** A number of large tubercle nodules in the spleen, and numerous small grey points in the liver; mesenteric, mesocolic, and cœliac glands enormously enlarged and tubercular; intestines, both large and small, extensively ulcerated; poststernal, posterior mediastinal, and bronchial glands, all enlarged and tubercular. A number of minute tubercular points in the lungs. Microscopic examinations, tubercle bacilli found.
1 do.	Do.	Killed 119	**Tubercular.** In a very similar condition to the above. Microscopic examination, tubercle bacilli found.
3			
Injection controls for No. 6 showed tubercle.			
Do.	No. 8	do.	
1 guinea-pig	10 = 33 cc.	Died 24	Too early to show tubercle.
1 do.	Do.	Killed 129	**Tubercular.** Spleen tremendously enlarged and tubercular; liver studded with several distinct yellow nodules; pancreas and cœliac and mesocolic glands tubercular; intestines ulcerated; bronchial glands and lungs affected with early tubercle. Microscopic examination, tubercle bacilli found.
1 do.	Do	Killed 129	Nil.
3			

TABLE CV.—*continued.*

Feeding Experiments with Milk to which manifestly Tubercular Material had been added, Heated at 60° C. (140° F.)—*cont.*

No. of Animals.	Time Heated.	Number of Feedings and Amount.	Killed or Died. No. of Days.	Post-mortem Examination and Remarks.
1 pig	**30** minutes	11, 12, 13 = 3,000 cc.	Killed 85	**Tubercular.** Tonsil and pharynx normal in appearance, but the parotid, submental and submaxillary glands very much enlarged; indurated and tubercular gland in the neck; mediastinal and bronchial glands enlarged, caseo-calcareous. The ribs are covered with "grapes"; "grapes" also extend on to the diaphragm; left lung infiltrated with tubercle, right in the same condition, but not so far advanced; tubercle nodules about the size of a pea in both spleen and liver; deep inguinal, mesenteric, mesocolic, cœliac glands, and glands at hilus of liver slightly affected; intestines normal. Microscopic examination, tubercle bacilli found.
1 cat	**30** minutes	12, 13 = 1,100 cc.	Killed 89	Nil.
1 guinea-pig	**35** minutes	1, 2 = 85 cc.	Died 88	Nil. Two grey points in liver; on microscopic examination found to be fatty patches.
1 do.	Do.	Do.	Died 102	Nil.
1 do.	Do.	1, 2, 3, 4, 5 = 470 cc.	Killed 149	Nil.
3				
1 guinea-pig	**45** minutes	1, 2, 3, 4, 5, 6, 7, 8, 9, 10 = 1,200 cc.	Died 209	Nil.
1 do.	Do.	Do.	Killed 251	Nil.
1 do.	Do.	Do.	Killed 251	Nil.
3				
1 guinea-pig	**1** hour	1, 2 = 85 cc.	Died 70	Nil.
1 do.	Do.	1, 2, 3, 4, 5, 6, 7, 8, 9, 10 = 1,800 cc.	Died 206	Nil.
1 do.	Do.	Do.	Killed 251	Nil.
3				
1 pig	**1** hour	11, 12, 13 = 3,000 cc.	Killed 85	**Tubercular.** Tonsils and pharynx normal, but the parotid and submental glands are all affected, especially on the right side; glands in neck, the mediastinal and bronchial glands slightly enlarged and studded with numerous white or pearly miliary tubercles. No tubercles on the chest wall or diaphragm; three small tubercle nodules in spleen, and many in the liver: mesenteric glands had small tubercle nodules in the cortex; all other organs and parts normal. Microscopic examination, tubercle bacilli found.

Control Feeding Experiments—*cont.*

No. of Animals.	Number of Feedings and Amount.	Killed or Died. No. of Days.	Post-mortem Examination and Remarks.
1 cat	10 = 750 cc.	Killed 77	**Tubercular.** Two tubercular patches in the centre of one of the mesenteric glands, none in the medulla; other organs normal. Microscopic examination, tubercle bacilli found.
1 pig	11 = 1,000 cc.	Died 42	**Tubercular.** Both tonsils studded with small ulcers and nodules of yellow tubercle; the sublingual and submental glands were caseous, and from these extended a chain of caseous glands down to each axilla; the anterior and posterior mediastinal and bronchial glands were enlarged and caseous; the lungs showed a few grey miliary tubercles, and there was marked consolidation of the left lung; spleen infiltrated with miliary tubercles throughout; liver mottled with numerous yellow patches; the cœliac, cæcal, and mesenteric glands were all enlarged and caseous; lumbar glands normal; stomach and cæcum normal; large intestine contained several small tubercles; in the small intestine every Peyer's patch was affected with tubercular ulceration, with numerous nodules (pin-head) of tubercle around each ulcer; there were several ulcers in other parts of the intestine; but none of these was larger than a shilling piece. Microscopic examination, tubercle bacilli found.
1 guinea-pig	13 = 66 cc.	Died 31	Nil. Broncho-pneumonia in lungs.
1 do.	Do.	Died 56	**Tubercular.** Cervical glands and those under jaw, mediastinal glands, and bronchial glands, all enlarged and tubercular; early tubercle of the lungs; liver and spleen tubercular; the glands at the hilus of the liver, cœliac, mesenteric, and one mesocolic gland, all affected; tubercular ulceration of the large intestine. Microscopic examination, tubercle bacilli found.
1 do.	Do.	Killed 75	**Tubercular.** Condition very similar to the foregoing.
3			

TABLE CV.—*continued.*

Feeding Experiments with Milk to which manifestly Tubercular Material had been added, Heated at 60° C. (140° F.) —*cont.*

Control Injection Experiments—*cont.*

No. of Animals.	Time Heated.	Number of Feedings and Amount.	Killed or Died. No. of Days.	Post-mortem Examination and Remarks.	No. of Animals.	Intraperitoneal Injection.	Killed or Died. No. of Days.	Post-mortem Examination and Remarks.
1 guinea-pig	**2** hours	2, 3, 4, 5 = 190 cc.	Died 86	Nil. Liver, yellowish, grey, non-tubercular patches on under surface.				
1 do.	Do.	2, 3, 4, 5, 8, 9, 10 = 840 cc.	Died 155	Nil.				
1 do.	Do.	Do.	Died 164	Nil. One mesenteric gland slightly enlarged; liver hard, yellow patch on under surface, which on section was found to contain yellow pus. Microscopic examination showed no evidences of tubercule.				
3								
1 guinea-pig	**8** hours	4, 8, 10 = 400 cc.	Died 119	Nil. Slight enlargement of one of the mesenteric glands, but it was not tubercular.				
1 do.	Do.	Do.	Died 122	Nil.				
1 do.	Do.	Do.	Killed 162	Nil.				
8								
1 guinea-pig	**18** hours	4, 6, 8, 9, 10 = 415 cc.	Died 113	Nil. Yellow point in mesenteric gland which, however, was not enlarged. Microscopic examination, no evidence of tubercle could be found.				
1 do.	Do.	Do.	Killed 162	Nil.				
1 do.	Do.	Do.	Killed 162	Nil.				
3								

TABLE CV.—*continued.*

Injection Experiments with Milk to which manifestly Tubercular Material had been added, Heated at 60° C. (140° F.)—*cont.*

No. of Animals.	Time Heated.	Intraperitoneal Injection.	Killed or Died. No. of Days.	Post-mortem Examination and Remarks.
1 guinea-pig	**5** minutes	1 = 2½ cc.	Died 8	Too early to show tubercle.
1 do.	Do.	2 = 2½ cc.	Killed 85	**Tubercular.** Tubercle at the seat of inoculation, and some peritonitis; spleen, liver, and diaphragm all affected with well marked tubercle; mesenteric, retroperitoneal, bronchial, mediastinal, and cervical glands all affected; early tubercle of the lungs. Microscopic examination, tubercle bacilli found.
1 do.	Do.	1 = 2½ cc.	Died 55	Nil.
3				
1 guinea-pig	**5** minutes	6, 8, 10 = 11 cc.	Died 33	**Tubercular.** Early tubercle of the liver and spleen; several yellow purulent caseous points in the pancreas; other organs normal. Microscopic examination, tubercle bacilli found.
1 do.	Do.	Do.	Died 54	**Tubercular.** Walls of abdominal cavity covered with tubercles; mesenteric glands tubercular; advanced tubercle of the liver and spleen; lungs normal. Microscopic examination, tubercle bacilli found.
1 do.	Do.	Do.	Died 93	**Tubercular.** Abdominal wall studded with tubercles; the spleen, pancreas, and liver are all markedly affected, as are also the glands in the hilus of the liver; diaphragm tubercular; lungs, bronchial glands and anterior mediastinal and cervical glands also tubercular. Microscopic examination, tubercle bacilli found.
3				
1 guinea-pig	**10** minutes	2 = 2½ cc.	Killed 85	**Tubercular.** Some peritonitis; spleen and liver adherent to the under surface of the diaphragm; one or two tubercle nodules in the spleen; liver, normal; diaphragm, well marked tubercle in the muscular portion, evidently near the points of adhesion; glands behind stomach and retroperitoneal glands distinctly tubercular and caseous.
1 do.	Do.	1, 2 = 5 cc.	Died 93	Nil.
1 do.	Do.	1, 2, 3, 4 = 15 c.	Killed 140	**Tubercular.** Very early tubercle of the spleen; mesenteric gland enlarged and tubercular; other organs normal. Microscopic examination, tubercle bacilli found.
3				
1 guinea-pig	**10** minutes	10 = 1 cc.	Died 103	**Tubercular.** Spleen enlarged and tubercular; caseous masses in the liver; cœliac and mesenteric glands enlarged and tubercular. Microscopic examination, tubercle bacilli found.
1 do.	Do.	6, 8, 10 = 11 cc.	Died 31	Nil. Intestines matted together.
1 do.	Do.	Do.	Died 40	Nil.
1 do.	Do.	8 = 5 cc.	Died 88	Nil.
4				

Control Injection Experiments—*cont.*

No. of Animals.	Number of Feedings and Amount.	Killed or Died. No. of Days.	Post-mortem Examination and Remarks.
1 cat	1 = 1 cc. subcutaneously.	Died 68	**Tubercular.** Mamma very tubercular; several large tubercle nodules on the spleen and liver; lungs also affected, but not so far advanced. Microscopic examination, tubercle bacilli found.
1 guinea-pig	1 = 2½ cc.	Died 33	**Tubercular.** Spleen only slightly affected; abscess had formed in the hilus of the liver, which contained soft yellow pus, and at this point the intestines were attached to the liver and anterior abdominal wall; other organs apparently normal. Microscopic examination, tubercle bacilli found.
1 Do.	Do.	Killed 54	**Tubercular.** A single tubercle nodule in the spleen; several tubercular patches in the liver; other organs normal.
1 Do.	Do.	Killed 127	Nil.
3			
1 guinea-pig	1A = 2 c.c½	Died 39	**Tubercular.** Early tubercle of the spleen. An abscess about the size of a pea had formed in the liver, causing adhesion between that organ and the diaphragm; pancreas enormously enlarged and tubercular; beautiful tubercles over the surface of the abdominal wall, and over the serous surfaces of the intestines; diaphragm studded with radiating tubercle running along the course of the lymphatic vessels; a number of tubercular points in the lungs; cervical glands enormously enlarged and cheesy.
1 do.	Do.	Died 41	**Tubercular.** Very similar to the foregoing, but not so far advanced, the cervical glands were not affected; cæcum tubercular. Microscopic examination, tubercle bacilli found.
1 do.	Do.	Died 95	**Tubercular.** Several tubercular points in the abdominal wall; spleen, liver, and pancreas, and mesenteric glands all much enlarged and tubercular; early tubercle of the lungs. Microscopic examination, tubercle bacilli found.
3			
1 guinea-pig	4 = 5 cc.	Died 22	**Tubercular.** Early tubercle of spleen, liver, and pancreas; glands in neck also enlarged. Microscopic examination, tubercle bacilli found.
1 Do.	Do.	Died 25	**Tubercular.** Well marked tubercle of the spleen, liver, and pancreas; early tubercle of the lungs. Microscopic examination, tubercle bacilli found.
1 Do.	Do.	Died 25	**Tubercular.** Spleen, liver, pancreas, and peritoneal wall all affected; early tubercle of the thoracic glands and lungs. Microscopic examination, tubercle bacilli found.
3			

TABLE CV.—*continued.*

Injection Experiments with Milk to which manifestly Tubercular Material had been added, Heated at 60° C. (140° F.)—*cont.*

No. of Animals.	Time Heated.	Intraperitoneal Injection.	Killed or Died. No. of Days.	Post-mortem Examination and Remarks.
1 guinea-pig	**15** minutes	1 = 2½ cc.	Killed 82	Nil.
1 do.	Do.	1, 3, 4 = 12½ cc.	Killed 140	**Tubercular.** Spleen somewhat enlarged; one early point evidently tubercular in the liver; early tubercle of the diaphragm. Microscopic examination, tubercle bacilli found.
1 do.	Do.	Do.	Killed 155	Nil.
3				
1 guinea-pig	**15** minutes	1A = 2½ cc.	Died 31	Nil.
1 do.	Do.	1, 2 = 5 cc.	Died 86	Nil.
1 do.	Do.	1, 2, 3 = 10 cc.	Died 96	Nil. One suspicious point in the liver. Microscopic examination showed no evidence of tuberculosis.
3				
1 guinea-pig	**15** minutes	6 = 5 cc.	Died 2	Too early to show tubercle.
1 do.	Do.	6, 8, 10 = 11 cc.	Died 40	Nil.
1 do.	Do.	Do.	Died 97	Nil.
3				
1 guinea-pig	**20** minutes	6, 8, 10 = 11 cc.	Died 140	**Tubercular.** Spleen slightly affected; liver markedly tubercular; mesenteric, mesocolic and cœliac glands and glands at hilus of liver all tubercular early tubercle of the lungs and pleura; poststernal, bronchial, mediastinal, and cervical glands all affected; a large quantity of turbid fluid in both pleural and abdominal cavities. Microscopic examination, tubercle bacilli found.
1 do.	Do.	6, 8 = 10 cc.	Died 23	Nil.
1 do.	Do.	Do.	Died 38	Nil.
3				
1 guinea-pig	**25** minutes	1A = 2½ cc.	Died 49	Nil.
1 do.	Do.	1, 2, 3, 4 = 15 cc.	Killed 149	Nil. Spleen, liver, and lungs normal; abdominal wall adherent to the liver; left kidney had a number of dark gelatinous nodules; the stomach also contained a number of sago-like bodies. Microscopic examination of spleen showed the presence of parasitic cysts.
1 do.	Do.	Do.	Killed 149	Nil.
3				

Control Injection Experiments—*cont.*

No. of Animals.	Intraperitoneal Injection.	Killed or Died. No. of Days.	Post-mortem Examination and Remarks.
1 guinea-pig	5 = 1 cc.	Died 13	Too early too show tubercle.
1 do.	Do.	Died 33	**Tubercular.** Well marked tubercles over the abdominal wall and throughout the mesenteric system; many fine points in the liver; spleen tubercular, but not nodular; early tuberculosis of the lungs; bronchial glands enlarged, but no pus yet formed in them; pleural and abdominal cavities filled with serous fluid. Microscopic examination, tubercle bacilli found.
1 do.	Do.	Died 40	**Tubercular.** Tubercle well marked in the spleen and liver, the former being much enlarged; pancreas and abdominal wall also affected; lungs and glands behind the stornum tubercular. Microscopic examination tubercle bacilli found.
3			
1 guinea-pig	6 = 1 cc.	Died 15	Too early to show tubercle.
1 do.	Do.	Died 19	**Tubercular.** Tubercle of spleen and omentum and of the peritoneal covering of the abdominal wall; gland at hilus of liver also affected. Microscopic examination, tubercle bacilli found.
1 do.	Do.	Died 19	**Tubercular.** Pancreas only affected, slightly nodular. Microscopic examination, tubercle bacilli found.
3			

TABLE CV.—*continued.*

Injection Experiments with Milk to which manifestly Tubercular Material had been added. Heated at 60° C. (140° F.)—*cont.*

No. of Animals.	Time Heated.	Intraperitoneal Injection.	Killed or Died. No. of Days.	Post-mortem Examination and Remarks.
1 guinea-pig	**30** minutes	1, 2, 3, 4 = 15 cc.	Killed 155	Nil.
1 do.	Do.	1, 2 = 5 cc.	Died 93	Nil.
1 do.	Do.	1 = 2½ cc.	Died 63	Nil.
3				
1 guinea-pig	**30** minutes	6, 8, 10 = 11 cc.	Died 34	**Tubercular.** Spleen, several small nodules bound down by adhesions in which are small abscesses connecting it with the abdominal wall; several white patches in the liver; retroperitoneal glands, enlarged tubercular; one tubercle nodule in the lung. Microscopic examination, tubercle bacilli found.
1 do.	Do.	Do.	Died 45	**Tubercular.** Spleen not enlarged, but tubercular; liver in a more advanced stage of tuberculosis; very early points of tubercle in the lungs. Microscopic examination, tubercle bacilli found.
1 do.	Do.	Do.	Died 54	**Tubercular.** Extensive tubercle in the liver and spleen; mesenteric glands and lymphatic system, also tubercular; other organs normal. Microscopic examination, tubercle bacilli found.
3				
1 guinea-pig	**35** minutes	1A, 2, 3, 4 = 15 cc.	Killed 149	Nil.
1 do.	Do.	Do.	Killed 149	Nil.
1 do.	Do.	2, 3, 4 = 13½ cc.	Killed 100	Nil.
3				
1 guinea-pig	**45** minutes	1 = 2½ cc.	Died 19	Too early to show tubrecle.
1 do.	Do.	D .	Died 55	**Tubercular.** Spleen distinctly tubercular; liver slightly affected, the points being much smaller than in the spleen. Microscopic examination, tubercle bacilli found.
1 do.	Do.	1, 2, 3, 4 = 15 cc.	Killed 155	Nil.
3				
1 guinea-pig	**45** minutes	6, 8, 10 = 11 cc.	Died 39	**Tubercular.** Spleen and liver enlarged and tubercular; pancreas studded with sago-like nodules; a number of tubercular points on the abdominal wall, these were still hard and fibrous, and contained no purulent matter; other organs normal. Microscopic examination, tubercle baccilli found.
1 do.	Do.	Do.	Died 49	**Tubercular.** Abdominal cavity, spleen, liver, pancreas, and omentum all markedly tubercular; early tubercle of the lung. Microscopic examination, tubercle bacilli found.
1 do.	Do.	Do.	Killed 149	Nil.
1 do.	Do.	Do.	Died 115	**Tubercular.** Caseous tubercular mass at the seat of inoculation; spleen, liver, and lymphatic glands connected with these, tubercular; the thymus and the bronchial and mediastinal glands and lungs all affected. Microscopic examination, tubercle bacilli found.
4				

Control Injection Experiments—*cont.*

No. of Animals.	Intraperitoneal Injection.	Killed or Died. No. of Days.	Post-mortem Examination and Remarks.
1 guinea-pig	8 = 1 cc.	Died 26	**Tubercular.** Spleen, liver, and pancreas studded with well marked tubercle; mesenteric and retroperitoneal glands tubercular; well marked tubercles scattered over the abdominal wall; very early tubercle of the lungs. Microscopic examination, tubercle bacilli found.
1 do.	Do.	Died 27	**Tubercular.** Similar condition to foregoing. Microscopic examination, tubercle bacilli found.
1 do.	Do.	Died 39	**Tubercular.** Spleen tubercular, but not much enlarged; many tubercular patches in the liver; abdominal wall tubercular; very early tubercular points in the lungs. Microscopic examination, tubercle bacilli found.
3			
Feedings for No. 10 showed tubercle.			
1 guinea-pig	14 = 1 cc.	Killed 40	**Tubercular.** Wound open, indurated, and contained a certain amount of pus; inguinal glands enlarged and purulent; spleen much enlarged and contained numerous white nodules; liver also contained numerous white nodules; cœliac gland enlarged and tubercular; poststernal glands also affected, but the lungs normal. Microscopic examination, tubercle bacilli found.
1 do.	Do.	Killed 40	**Tubercular.** Very similar condition to the above. Microscopic examination, tubercle bacilli found.
1 do.	Do.	Died 16	**Tubercular.** Subcutaneous abscess and thickening of skin at the seat of injection; superficial inguinal gland slightly enlarged. Microscopic examination, tubercle bacilli found.
3			

TABLE CV.—*continued.*

Injection Experiments with Milk to which manifestly Tubercular Material had been added, Heated at 60° C. (140° F.)—*cont.*

Control Injection Experiments—*cont.*

No. of Animals.	Time Heated.	Intraperitoneal Injection.	Killed or Died. No. of Days.	Post-mortem Examination and Remarks.	No. of Animals.	Intraperitoneal Injection.	Killed or Died. No. of Days.	Post-mortem Examination and Remarks.
1 guinea-pig	**45** minutes	14 = 1 cc. -	Died 37	**Tubercular.** Early tubercle of the spleen, pancreas and mesenteric glands; more advanced stage in the deep inguinal and cœliac glands; poststernal glands also affected; other organs normal. Microscopic examination, tubercle bacilli found.				
1 do. -	Do. -	Do. -	Died 37 -	**Tubercular.** Very early tubercle in the spleen and in the glands along the pancreas and at the hilus of the liver; poststernal glands slightly affected; other organs normal. Microscopic examination, tubercle bacilli found.				
1 do. -	Do. -	Do. -	Died 34 -	**Tubercular.** Point of injection tubercular; spleen affected; mesenteric, inguinal, poststernal. and cervical glands all tubercular; diaphragm and gland near the left suprarenal capsule affected. Microscopic examination, tubercle bacilli found.				
3								
1 guinea-pig	**1** hour -	1, 2 = 5 cc. -	Killed 82 -	Nil.				
1 do. -	Do. -	1, 2, 3, 4 = 15 cc. -	Died 164 -	Nil.				
1 do. -	Do. -	Do. -	Died 166 -	Nil.				
3								
1 guinea-pig	**1** hour -	8, 10 = 6 cc. -	Killed 90 -	Nil.				
1 do. -	Do. -	Do. -	Killed 90 -	Nil.				
1 do. -	Do. -	6, 8, 10 = 11 cc. -	Died 32 -	Nil. Intestines matted together; spleen enormously enlarged and contained a large white patch evidently of a purulent nature, its surface was nodular; other organs normal. Microscopic examination showed necrotic areas very similar to those described as of "bacterial" origin. No tubercle bacilli could be found, but a number of short rods stained blue were found at the margin of the necrosed patch.				
3								
1 guinea-pig	**1** hour -	14 = 1 cc. -	Died 6 -	Too early too show tubercle.				
1 do. -	Do. -	Do. -	Killed 62 -	**Tubercular.** Two tubercle nodules in the spleen; several points of scar-tissue-like tubercle in the liver; early tubercle of the mesenteric glands. Microscopic examination, tubercle bacilli found.				
1 do.	Do. -	Do. -	Killed 62 -	**Tubercular.** Spleen and pancreas extensively affected with tubercle; liver affected over its whole surface; mesenteric glands much enlarged and caseous; anterior mediastinal and bronchial glands enlarged and hard; several tubercular points in the lungs. Microscopic examination, tubercle bacilli found.				
3								
1 guinea-pig	**1¼** hours -	14 = 1 cc. -	Died 22 -	Nil.				
1 do. -	Do. -	Do. -	Killed 62 -	**Tubercular.** Spleen enlarged and tubercular, scar tissue-like tubercle; mesenteric glands, and those in thorax and at the root of the lungs and liver also distinctly affected. Microscopic examination, tubercle bacilli found.				
1 do. -	Do. -	Do. -	Killed 62 -	**Tubercular.** Several tubercle nodules in the spleen; a number of very fine points in the liver; other organs apparently normal.				
3								

TABLE CV.—*continued.*

Injection Experiments with Milk to which manifestly Tubercular Material had been added, Heated at 60° C. (140° F.)—*cont.*					Control Injection Experiments—*cont.*			
No. of Animals.	Time Heated.	Intraperitoneal Injection.	Killed or Died. No. of Days.	Post-mortem Examination and Remarks.	No. of Animals.	Intraperitoneal Injection.	Killed or Died. No. of Days.	Post-mortem Examination and Remarks.
1 guinea-pig	**1½** hours	14 = 1 cc.	Died 37	Nil.				
1 do.	Do.	Do.	Died 34	Nil.				
1 do.	Do.	Do.	Killed 62	**Tubercular.** Four tubercle nodules in the spleen; a number of distinct yellow nodules in the liver; mesenteric glands hard and almost cartilaginous; other organs normal. Microscopic examination, tubercle bacilli found.				
3								
1 guinea-pig	**2** hours	1, 2, 3, 4 = 10 cc.	Died 132	Nil.				
1 do.	Do.	Do.	Died 132	Nil.				
1 do.	Do.	4 = 5 cc.	Died 17	Too early to show tubercle.				
3								
1 guinea-pig	**2** hours	14 = 1 cc.	Died 37	**Tubercular.** Spleen, tubercular; early tubercle of the liver; gland in hilus of liver, cœliac and mesenteric and posternal glands all affected; other organs normal. Microscopic examination, tubercle bacilli found.				
1 do.	Do.	Do.	Killed 62	**Tubercular.** Very early tubercle nodules in the spleen; early stage of scar-tissue tubercle in the liver; mesenteric glands slightly enlarged; other organs normal. Microscopic examination, tubercle bacilli found.				
1 do.	Do.	Do.	Killed 62	**Tubercular.** Spleen obviously tubercular; large white patches in the liver; mesenteric glands, and those in the thorax affected; grey points in the lungs. Microscopic examination, tubercle bacilli found.				
3								
1 guinea-pig	**8** hours	4 = 5 cc.	Died 79	Nil.				
1 do.	Do.	Do.	Died 79	Nil.				
1 do.	Do.	Do.	Died 79	Nil.				
3								
1 guinea-pig	**18** hours	4 = 5 cc.	Died 39	Nil.				
1 do.	Do.	Do.	Died 44	Nil.				
1 do.	Do.	Do.	Died 96	Nil.				
3								
1 guinea-pig	**18** hours	8, 9, 10 = 11 cc.	Died 24	Nil.				
1 do.	Do.	Do.	Killed 90	Nil.				
2								

TABLE CVI.

Experiments with Milk to which manifestly Tuberculous Material had been added, exposed to a Temperature of 65° C. (149° F.).

Materials used.

(1.) Tubercular organs of guinea pigs + sound milk.
Control experiments { **Feeding, 3** guinea pigs, **3 tubercular.**
Injection, 3 guinea pigs, **3 tubercular.** }
(2.) Tubercular organs of guinea pigs + sound milk.
Control experiments.—**Feeding, 3** guinea pigs, **3 tubercular.**
(3.) Tubercular milk from Cow No. 25.
(4.) Tubercular milk of Cow No. 25 + tubercular organs of guinea pigs + sound milk.
Control experiments { **Feeding, 3** guinea pigs, **2 tubercular,** 1 died too early to show tubercle.
Injection, 3 guinea pigs, **2 tubercular,** 1 died too early to show tubercle. }
(5.) Tubercular glands from guinea pigs + sound milk.
Control experiments.—**Injection, 2** guinea pigs, **2 tubercular.**
(6.) Tubercular organs of pig and guinea pigs + sound milk.
Control experiments.—**Injection, 3** guinea pigs, **2 tubercular,** 1 died too early to show tubercle.
(7.) Tubercular grapes from Metropolitan Cattle Market + tubercular guinea-pig organs + sound milk.
Control experiments.—**Injection, 3** guinea pigs, **3 tubercular.**
(8.) Tubercular organs of guinea-pigs + sound milk.
(9.) Tubercular milk from Cow No. 25 + sound milk.
(10.) Tubercular human lung + sound milk.
Control experiments.—**Feeding, 1 tubercular,** 2 nil; **1 cat tubercular.**
(11.) Tubercular human lung + sound milk.
Control experiments.—**Feeding, 3** guinea pigs, **1 tubercular,** 2 died too early to show tubercle.
(12.) Tubercular human lung + sound milk.
Control experiments { **Feeding, 3** guinea pigs, 3 nil.
Injection, 3 guinea pigs, **1 tubercular,** 2 died too early to show tubercle. }
(13.) Tubercular lung of Cow No. 33 + sound milk.
Control experiment.—**Feeding, 1 pig tubercular.**
(14.) Same material as above.
(15.) Tubercular human lung + sound milk.
Control experiments { **Feeding, 3** guinea pigs, **2 tubercular,** 1 nil.
Injection, 3 guinea pigs, **2 tubercular,** 1 died too early to show tubercle. }
(16.) Tubercular sputum from Victoria Park Hospital + sound milk.
Control experiment.—**1** kitten **tubarcular.**
(17.) Tubercular udder and grapes received from Metropolitan Cattle Market.

Feeding Experiments with Milk to which manifestly Tubercular Material had been added, Heated at 65° C. (149° F.).

No. of Animals.	Time Heated.	Number of Feedings and Amount.	Killed or Died. No. of Days.	Post-mortem Examination and Remarks.
1 guinea-pig	Heated to 65° C.	12 = 70 cc.	Died 26	Too early to show tubercle.
1 do.	Do.	Do.	Killed 89	Nil.
1 do.	Do.	Do.	Killed 89	Nil.
3				
1 guinea-pig	2½ minutes	1, 2, 3, 4, 7, 8, 9, 10, 11, 12, =710 cc.	Killed 273	Nil.
1 do.	Do.	Do.	Died 145	Nil.
1 do.	Do.	Do.	Killed 273	Nil.
3				

Control Feeding Experiments.

No. of Animals.	Number of Feedings and Amount.	Killed or Died. No. of Days.	Post-mortem Examination and Remarks.
1 guinea pig	1, 3, 4 = 140 cc.	Died 142	**Tubercular.** A couple of tubercle nodules in the spleen; one much larger than the other.
1 do.	1, 3, 4, 6, 7 = 390 cc.	Died 184	**Tubercular.** Mesocolic glands tubercular, small tubercle nodules in the intestine. On microscopic examination tubercle bacilli were found.
1 do.	Do.	Died 241	**Tubercular.** Spleen not very much enlarged, but contains tubercle nodules; two or three patches of tubercle in the liver; glands at hilus of liver and mesenteric glands enormously enlarged and filled with pus; ulcers in the small intestine and in the cæcum; bronchial glands enlarged and tubercular; one or two very early tubercular points in the lung. On microscopic examination tubercle bacilli found.
3			

TABLE CVI.—*continued.*

Feeding Experiments with Milk to which manifestly Tubercular Material had been added, Heated at 65° C. (149° F.)—*cont.*

No. of Animals.	Time Heated.	Number of Feedings and Amount.	Killed or Died. No. of Days.	Post-mortem Examination and Remarks.
1 guinea pig	**5** minutes	12, 13 = 170 cc.	Killed 307	Nil.
1 do.	Do.	1 = 50 cc.	Died 70	Nil.
1 do.	Do.	11 = 50 cc.	Died 9	Too early to show tubercle.
3				
1 guinea-pig	**10** minutes	1, 2, 3 = 300 cc.	Died 135	Nil.
1 do.	Do.	11, 12 = 170 cc.	Killed 118	Nil.
1 do.	Do.	1, 2, 3, 4, 7, 8, 9, 10, 11, 12 = 750 cc.	Died 301	**Tubercular.** Glands in the neck, mediastinal and bronchial glands, lungs, spleen, liver, and pancreas, mesenteric and cœliac glands all tubercular. Diaphragm markedly affected. Small tubercular ulcers in the intestine. Microscopic examination, tubercle bacilli found.
1 do.	Do.	11, 1 = 170 cc.	Killed 118	Nil.
4				
1 kitten	**10** minutes	14, 15, 16, 17 = 1,500 cc.	Killed 89	Nil.
1 guinea-pig	**15** minutes	1, 2, 3, 4, 7 = 650 cc.	Died 194	Nil.
1 do.	Do.	Do.	Died 194	Nil.
1 do.	Do.	Do.	Died 198	Nil.
1 do.	Do.	12 = 150 cc.	Killed 81	Nil.
1 do.	Do.	Do.	Killed 83	Nil.
5				
1 guinea pig	**20** minutes	1, 2, 3, 4, 7, 8, 9, 10, 11 = 750 cc.	Died 137	Nil. Small non-tubercular but parasitic patches in the liver.
1 do.	Do.	Do.	Killed 206	Nil.
1 do.	Do.	Do.	Died 173	**Tubercular.** Cervical glands and bronchial and posterior mediastinal glands enlarged and caseous, the spleen and liver contained numerous patches of caseous tubercle. Mesenteric glands, tubercular. A single caseo-calcareous nodule (tubercular) in the small intestine. Microscopic examination, tubercle bacilli found.
3				

Control Feeding Experiments—*cont.*

No. of Animals.	Number of Feedings and Amount.	Killed or Died. No. of Days.	Post-mortem Examination and Remarks.
1 guinea pig	10 = 33 cc.	Died 24	Nil.
1 do.	Do.	Killed 129	**Tubercular.** Spleen enormously enlarged and tubercular; several distinct, yellow. nodules in the liver; pancreas tubercular; cœliac and mesocolic, glands tubercular; tubercular ulceration of the intestines; glands at the root of the lungs and the lungs themselves only slightly affected. Microscopic examination, tubercle bacilli found.
1 do.	Do.	Killed 129	Nil.
3			
1 cat	10 = 750 cc.	Killed 77	**Tubercular.** Two small tubercular patches in one of the enlarged mesenteric glands, none in the medulla; organs otherwise normal. Microscopic examination, tubercle bacilli found.
1 guinea-pig	11 = 100 cc.	Died 7	Too early to show tubercle.
1 do.	Do.	Died 7	Too early to show tubercle.
1 do.	Do.	Died 33	**Tubercular.** Mesenteric glands slightly enlarged, show early tubercle; large intestine, especially the cæcum, tubercular. Microscopic examiuation, tubercle bacilli found.
3			
1 guinea-pig	12 = 66 cc.	Died 48	Nil.
1 do.	Do.	Killed 89	Nil.
1 do.	Do.	Killed 89	Nil.
3			
1 pig	13 = 1,000 cc.	Died 42	**Tubercular.** Numerous small ulcers and nodules of yellow tubercle in the tonsils, sub-lingual, and sub-mental glands; from these a chain of caseous glands extends down to each axilla; poststernal, bronchial, and posterior mediastinal glands enlarged and caseous; a few grey miliary tubercles are seen in the lungs, left lung markedly consolidated throughout; spleen infiltrated with small tubercle nodules; yellow patches in the liver not tubercular but probably fatty; the cœliac, mesenteric, and mesocolic, glands enlarged and caseous; well marked tubercular ulceration of all the Peyer's patches in the small intestine, none larger than a shilling piece; these were surrounded by small solitary follicular tubercle nodules; in large intestine were several small follicular tubercles. Microscopic examination, tubercle bacilli found.
1 guinea-pig	15 = 66 cc.	Died 31	Nil. Broncho-pneumonic consolidation, but no tubercle.
1 do.	Do.	Died 56	**Tubercular.** Glands in the neck and under the jaw enormously enlarged and tubercular; poststernal, bronchial and posterior mediastinal glands tubercular; early tubercle of the lung; cœliac, mesenteric, and mesocolic glands, and glands in the hilus of the liver tubercular; tubercle of the spleen and liver; tubercular patches throughout both large and small intestines. Microscopic exmination, tubercle bacilli found.
1 do.	Do.	Killed 75	**Tubercular.** Similar to the above, but tubercular ulceration of the intestines even more marked.
3			
1 kitten	16 = 200 cc.	Died 38	**Tubercular.** Mesocolic and cæcal glands enormously enlarged, and tubercular; a number of smaller mesenteric glands were distinctly tubercular; nothing in the intestines. Microscopic examination, tubercle bacilli found.

TABLE CVI.—*continued.*

Feeding Experiments with Milk to which manifestly Tubercular Material had been added, Heated at 65° C. (149° F.)—*cont.*					**Control Feeding Experiments**—*cont.*			
No. of Animals.	Time heated.	Number of Feedings and Amount.	Killed or Died. No. of Days.	Post-mortem Examination and Remarks.	No. of Animals.	Number of Feedings and Amount.	Killed or Died. No. of Days.	Post-mortem Examination and Remarks.
1 pig -	**20** minutes	14, 15=3,000 cc. -	Killed 85 -	**Tubercular.** Early tubercle of the parotid and submental glands; "grapes" on the chest wall, but not far advanced. Lungs extensively infiltrated with numerous white, hard, and almost cartilaginous nodules; glands at root of lung, and bronchial and posterior mediastinal glands enlarged and tubercular. Four tubercle nodules about the size of a pea in the spleen; numerous small white tubercles in the liver; also small nodules in the pancreas; mesenteric glands enlarged and indurated, but not yet caseous. Tubercular nodules on the serous surface of both the large and small intestines, none on the mucuous surface. Microscopic examination, tubercle bacilli found.				
1 kitten -	**20** minutes	14,15,16,17=1,500 cc.	Died 26 -	Nil.				
1 guinea-pig	**25** minutes	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12=710 cc.	Died 253 -	**Tubercular.** Chain of glands in the neck and under the jaw slightly enlarged, as are also the glands in the axilla. Glands in both groins enlarged. Lungs covered with grey miliary tubercles with, here and there, a few caseating patches; glands at the root of the lung and behind the sternum enlarged and full of firm pus. Spleen enlarged and very tubercular. Liver in a similar condition. Mesenteric glands enlarged and tubercular. Three Peyer's patches in the intestine affected with early tubercle. Microscopic examination, tubercle bacilli found.				
1 do. -	Do. -	Do. -	Killed 306 -	Nil.				
1 do. -	Do. -	Do. -	Killed 306 -	Nil.				
3								
1 guinea-pig	**30** minutes	1, 2, 3, 4, 5, 6, 7, 8, 9=600 cc.	Died 179 -	Nil.				
1 do. -	Do. -	Do. -	Died 211 -	Nil.				
1 do. -	Do. -	12 = 150 cc.	Killed 79 -	Nil.				
1 do. -	Do. -	Do. -	Killed 79 -	Nil.				
4								
1 kitten -	**30** minutes	14,15,16,17=1,500 cc.	Died 26 -	Nil.				
1 pig -	**40** minutes	14, 15 = 3,000 cc. -	Killed 85 -	**Tubercular.** Glands in the neck slightly enlarged but not tubercular. Mediastinal and bronchial glands enormously enlarged and tubercular. Large tubercle nodules in both lungs, but the right is more extensively affected than the left. "Grapes" scattered over the chest wall; well marked tubercle of the diaphragm, where it is adherent to the liver. One or two pea-sized nodules in the spleen. Well marked tuberculosis throughout the liver, but especially where it is adherent to the diaphragm. Cœliac glands and those at the hilus of the liver, and the mesenteric and mesocolic glands tubercular. Other organs normal. Microscopic examination, tubercle bacilli found.				
1 guinea-pig	**45** minutes	12 = 70 cc.	Killed 89 -	Nil.				
1 do. -	Do. -	Do. -	Killed 89 -	Nil.				
1 do. -	Do. -	Do. -	Killed 89 -	Nil.				
3								

TABLE CVI.—*continued.*

Feeding Experiments with Milk to which manifestly Tubercular Material had been added, Heated at 65° C. (149° F.)—*cont.*

Control Feeding Experiments—*cont.*

No. of Animals.	Time heated.	Number of Feedings and Amount.	Killed or Died. No. of Days.	Post-mortem Examination and Remarks.	No. of Animals.	Number of Feedings and Amount.	Killed or Died. No. of Days.	Post-mortem Examination and Remarks.
1 kitten -	**45** minutes	16, 17 = 400 cc.	Killed 69 -	Nil.				
1 guinea-pig	**1** hour -	1, 2, 3, 4, 5, 6, 7, 8, 9, 10 = 500 cc.	Died 141 -	Nil.				
1 do. -	Do. -	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12 = 750 cc	Killed 244 -	Nil.				
1 do. -	Do. -	Do. -	Died 238 -	**Tubercular.** Spleen and liver tubercular; cœliac glands, those at the hilus of the liver and mesenteric glands all tubercular. Lungs, poststernal, posterior mediastinal, bronchial and cervical glands all tubercular. The tubercle was firm and hard, but very characteristic. Microscopic examination, tubercle bacilli found.				
3								
1 guinea-pig	**2** hours -	3, 4 = 120 cc.	Died 25 -	Too early to show tubercle.				
1 do. -	Do. -	3, 4, 5, 6, 7, 8, 9, 10, 11, 12 = 870 cc.	Killed 161 -	Nil.				
1 do. -	Do. -	Do. -	Killed 161 -	Nil.				
3								
1 guinea-pig	**4** hours -	4, 5 = 120 cc.	Died 105 -	Nil.				
1 do. -	Do. -	4, 5, 6, 7, 8, 9, 10, 11 = 600 cc.	Died 112 -	Nil.				
1 do. -	Do. -	Do. -	Killed 68 -	Nil.				
3								
1 guinea-pig	**8** hours -	3, 4, 5, 8, 9, 10, 11 = 600 cc.	Died 159 -	Nil.				
1 do. -	Do. -	Do. -	Killed 212 -	Nil.				
1 do.	Do. -	Do. -	Killed 186 -	Nil.				
3								
1 guinea-pig	**18** hours -	3, 4, 5, 6, 8, 9, 10 11 = 600 cc.	Died 96 -	Nil.				
1 do. -	Do. -	Do. -	Died 101 -	Nil.				
1 do. -	Do. -	Do. -	Died 115 -	Nil. Patch or area of white nodules on under surface of liver. Microscopic examination showed fatty liver but no evidence of tubercle.				
1 do. -	Do. -	11 = 100 cc.	Killed 210 -	Nil.				
4								
1 guinea-pig	**18** hours -	11 = 150 cc.	Killed 120 -	Nil.				
1 do.	Do. -	Do. -	Killed 120 -	Nil.				
2								

TABLE CVI.—*continued.*

Injection Experiments with Milk to which manifestly Tubercular Material had been added, Heated at 65° C. (149 F.)

No. of Animals.	Time Heated.	Intraperitoneal Injections.	Killed or Died. No. of Days.	Post-mortem Examination and Remarks.
1 guinea-pig	Heated to **65° C.**	12 = 2½ cc.	Died 2	Too early to show tubercle.
1 do.	Do.	Do.	Died 28	**Tubercular.** Spleen enlarged and tubercular; tubercles scattered irregularly throughout the liver; gland in hilus of liver enlarged, indurated, and tubercular; cœliac and mesenteric glands only slightly affected; mediastinal and bronchial glands tubercular, enlarged, hardened, containing firm pus; a number of grey miliary tubercles and one or two caseous patches in the lung. Microscopic examination, tubercle bacilli found.
1 do.	Do.	Do.	Killed 89	**Tubercular.** Spleen slightly enlarged and tubercular; liver apparently normal, but a gland in the hilus enlarged, hard, and tubercular; mesenteric glands slightly affected; mediastinal glands and glands at the root of the lung enlarged, but the lungs themselves are apparently normal. Microscopic examination, tubercle bacilli found
3				
1 guinea-pig	**2½** minutes	1 = 2½ cc.	Killed 46	Nil.
1 do.	Do.	Do.	Died 64	Nil.
1 do.	Do.	1, 2 = 7½ cc.	Died 93	Nil. One small white point in the liver. Microscopic examination showed neither tubercle bacilli nor tubercular structure.
1 do.	Do.	Do.	Died 97	Nil.
4				
1 guinea-pig	**2½** minutes	12 = 1½ cc.	Killed 82	Nil.
1 do.	Do.	5, 6, 10 = 10 cc.	Died 23	Nil.
1 do.	Do.	11, 12 = 3 cc.	Died 50	Nil.
1 do.	Do.	12 = 1½ cc.	Killed 82	**Tubercular.** Spleen tubercular; several minute, grey, cartilaginous points on the anterior surface of the liver, and on the under surface one large tubercular nodule is seen; cœliac and mesenteric glands enlarged, as are also the mediastinal and bronchial glands; several large gelatinous points in the lungs. Microscopic examination, tubercle bacilli found.
4				
1 guinea-pig	**5** minutes	1 = 2½ cc.	Died 70	Nil.
1 do.	Do.	Do.	Died 71	Nil.
1 do.	Do.	Do.	Died 78	Nil.
1 do.	Do.	1, 2 = 7½ cc.	Died 93	Nil.
4				

Control Injection Experiments.

No. of Animals.	Intraperitoneal Injections.	Killed or Died. No. of Days.	Post-mortem Examination and Remarks.
1 guinea-pig	1 = 2½ cc.	Died 39	**Tubercular.** Glands in the neck enormously enlarged and cheesy; a number of tubercular points in the lung; early tubercle of the spleen; pancreas enormously enlarged and tubercular; beautiful early tubercle of the liver; an abscess about the size of a pea near the surface of the liver causing adhesion to the diaphragm, which was traversed by radiating lines of tubercle following the course of the lymphatics; well marked tubercle nodules all over the abdominal wall and mesentery and serous surfaces of the intestines.
1 do.	Do.	Died 41	**Tubercular.** Very similar to above, but not so far advanced. Microscopic examination, tubercle bacilli found in considerable numbers.
1 do.	Do.	Died 95	**Tubercular.** Also like No. 1 of this set, but still more advanced. Microscopic examination, tubercle bacilli found.
3			
1 guinea-pig	5 = ½ cc.	Died 58	**Tubercular.** A subcutaneous abscess at the seat of inoculation; spleen markedly tubercular; a couple of tubercular nodules in the liver. Microscopic examination, tubercle bacilli found.
1 do.	Do.	Died 80	**Tubercular.** Spleen, liver and mesenteric glands all distinctly tubercular; the lungs and mediastinal glands tubercular. On microscopic examination, tubercle bacilli were found.
2			
1 guinea-pig	6 = 1 cc.	Died 15	Too early to show tubercle.
1 do.	Do.	Died 19	**Tubercular.** Tubercle of the spleen, omentum and peritoneal covering of the abdominal wall; glands at the hilus of the liver and the cœliac glands tubercular. Microscopic examination, tubercle bacilli found.
1 do.	Do.	Died 19	**Tubercular.** A few tubercular nodules of the pancreas; no other tubercle anywhere. Microscopic examination, tubercle bacilli found.
3			
1 guinea-pig	7 = 1 cc.	Died 26	**Tubercular.** Well marked tubercle of the spleen, liver, and pancreas; mesenteric and cœliac glands and the wall of the abdomen all tubercular; Very early tubercle of the lungs. Microscopic examination, tubercle bacilli found.
1 do.	Do.	Died 27	**Tubercular.** Well marked tubercle, similar to the above. Microscopic examination, tubercle bacilli found.
1 do.	Do	Died 39	**Tubercular.** Spleen tubercular, but not much enlarged; scattered tubercular nodules in the liver; peritoneal covering of the abdominal walls tubercular; early points of tubercle in the lungs. On microscopic examination a very large number of tubercle bacilli were found.
3			
1 guinea-pig	12 = 2½ cc. (subcutaneously).	Died 2	Too early to show tubercle.
1 do.	Do.	Died 2	Do. do.
1 do.	12 = ½ cc.	Killed 89	**Tubercular.** Large abscess at the seat of inoculation, also at the point of entrance of the needle into the abdominal wall; glands in the groin and axilla also affected; spleen extensively tubercular; cœliac and other mesenteric glands affected, but no evidence of suppuration; mediastinal glands and lungs only slightly affected. Microscopic examination, tubercle bacilli found.
3			

TABLE CVI.—*continued.*

Injection Experiments with Milk to which manifestly Tubercular Material had been added, Heated at 65° C. (149° F.)—*cont.*

No. of Animals.	Time Sterilised.	Intraperitoneal Injection.	Killed or Died. No. of Days.	Post-mortem Examination and Remarks.
1 guinea-pig	**5** minutes	11 = 1½ cc.	Died 40	**Tubercular.** Spleen not much enlarged, but nodular; tubercular patches over the surface of the liver; mesenteric glands enlarged and caseous; mesentery covered with tubercular points, diaphragm covered with fine tubercles; mediastinal glands enlarged and firm; a number of grey points in the lungs. Microscopic examination, tubercle bacilli found.
1 do.	Do.	11, 12 = 4 cc.	Died 110	**Tubercular.** Spleen slightly tubercular; liver markedly enlarged and tubercular; gland at hilus of liver, and mesenteric glands all tubercular; mediastinal and bronchial glands tubercular; lungs only slightly affected. Microscopic examination, tubercle bacilli found.
1 do.	Do.	12 = 2½ cc.	Killed 92	**Tubercular.** Scar-like tissue in liver.
3				
1 guinea-pig	**10** minutes	1, 2, 3 = 12½ cc.	Died 134	**Tubercular.** Very minute tubercular points in the spleen; several small tubercular patches in the liver; mesenteric glands enlarged, tubercular, and cheesy; gland near the cæcum slightly enlarged.
1 do.	Do.	Do.	Killed 149	Nil. A number of gelatinous black nodules in the left kidney; a number of sago-like bodies on the outer surface of the stomach wall. Microscopic examination showed only small parasitic cysts.
1 do.	Do.	Do	Killed 149	Nil.
3				
1 guinea-pig	**10** minutes	12 = 2½ cc.	Died 75	Nil.
1 do.	Do.	Do.	Killed 82	**Tubercular.** A number of distinctly caseous nodules in the spleen; one or two very small grey points in the liver. Microscopic examination, tubercle bacilli found.
1 do.	Do.	11, 12 = 4 cc.	Died 115	**Tubercular.** Spleen, two large white nodules, and several in pancreas; white patches not far advanced, and harder than usual, found in the liver; mediastinal and bronchial glands enlarged and hard; several minute points in the lungs. Microscopic examination, tubercle bacilli found.
3				
1 guinea-pig	**15** minutes	1, 2 = 7½ cc.	Died 93	Nil.
1 do.	Do.	Do.	Died 93	Nil.
1 do.	Do.	Do.	Died 93	Nil.
3				
1 guinea-pig	**15** minutes	3 = 5 cc.	Died 87	Nil.
1 do.	Do.	Do.	Died 87	Nil.
1 do.	Do	11 = 1½ cc.	Killed 118	Nil.
1 do.	Do.	3, 10, 11 = 7½ cc.	Killed 161	Nil.
4				

Control Injection Experiments—*cont.*

No. of Animals.	Intraperitoneal Injection.	Killed or Died. No. of Days.	Post-mortem Examination and Remarks.
1 guinea-pig	15 = ½ cc.	Died 2	Too early too show tubercle.
1 do.	Do.	Died 60	**Tubercular.** A large abscess in the subcutaneous tissue of the abdominal wall; spleen, liver, and lungs markedly tubercular, as are also the axillary, popliteal, and superficial inguinal glands. Microscopic examination, tubercle bacilli found.
1 do.	Do.	Died 31	**Tubercular.** Spleen and liver, cœliac glands, and omentum all tubercular. Microscopic examination, tubercle bacilli found.
3			

TABLE CVI.—*continued.*

Injection Experiments with Milk to which manifestly Tubercular Material had been added, Heated at 65° C. (149° F.)—*cont.*

No. of Animals.	Time Sterilised.	Intraperitoneal Injection.	Killed or Died. No. of Days.	Post-mortem Examination and Remarks.
1 guinea-pig	**15** minutes	12 = 2½ cc.	Died 26	**Tubercular.** Mesenteric gland in the region of the cæcum enlarged and yellow; one of the poststernal glands evidently in a similar condition. Microscopic examination shows tubercle bacilli.
1 do.	Do.	6 = 5 cc.	Died 23	Nil.
1 do.	Do.	12 = 2½ cc.	Killed 89	**Tubercular.** Spleen extensively affected, large white nodules being scattered over the surface; a number of irregular tree-like patches over the surface of the liver not far advanced; the cœliac and mesenteric glands are caseous; mediastinal and bronchial glands enlarged and caseous; numerous white points in the lungs. Microscopic examination shows presence of tubercle bacilli.
3				
1 guinea-pig	**20** minutes	12 = 7½ cc.	Died 95	Nil.
1 do.	Do.	1, 2, 3 = 12½	Killed 149	Nil.
1 do.	Do.	Do.	Killed 149	Nil.
1 do.	Do.	Do.	Killed 149	Nil.
4				
1 guinea-pig	**20** minutes	11, 13 = 4 cc.	Killed 126	Nil.
1 do.	Do.	12 = 2½ cc.	Died 40	**Tubercular.** A few small yellowish grey points on the anterior margin of the liver; the mesenteric glands are filled with caseous pus. Microscopic examination shows presence of tubercle bacilli.
1 do.	Do.	Do.	Killed 89	Nil.
1 do.	Do.	6, 7, 10, 11 = 12½ cc.	Died 53	**Tubercular.** Tubercle at the seat of inoculation; the spleen is double the normal size and is obviously tubercular; well-marked tubercle of the liver; glands at the head of the pancreas also affected; the diaphragm exhibited radiating tubercle following the lines of the lymphatics; mediastinal and bronchial glands enlarged; small grey tubercular nodules in the lungs. Microscopic examination shows tubercle bacilli.
4				
1 guinea-pig	**25** minutes	1, 2 = 7½ cc.	Died 93	Nil.
1 do.	Do.	1, 2, 3 = 12½ cc.	Killed 149	Nil.
1 do.	Do.	Do.	Killed 149	Nil.
3				
1 guinea-pig	**25** minutes	11, 12 = 4 cc.	Killed 126	Nil.
1 do.	Do.	12 = 2½ cc.	Died 48	Nil. Lungs, some broncho-pneumonic consolidation.
1 do.	Do.	11, 12 = 4 cc.	Died 85	Nil. Lungs, extensive pneumonic consolidation.
3				

Control Injection Experiments—*cont.*

No. of Animals.	Intraperitoneal Injection.	Killed or Died. No. of Days.	Post-mortem Examination and Remarks.

TABLE CVI.—*continued.*

Injection Experiments with Milk to which manifestly Tubercular Material had been added, Heated at 65° C. (149° F.)—*cont.*

Control Injection Experiments—*cont.*

No. of Animals.	Time Sterilised.	Intraperitoneal Injection.	Killed or Died. No. of Days.	Post-morten Examination and Remarks.	No. of Animals.	Intraperitoneal Injection.	Killed or Died. No. of Days.	Post-mortem Examination and Remarks.
1 guinea-pig	**30** minutes -	1, 2, 3, 7 = 17	Died 191 -	Nil.				
1 do. -	Do. -	Do. - -	Died 192 -	Nil.				
1 do. -	Do. -	1, 2, 3, 7, 10 = 18½ cc.	Died 215 -	**Tubercular.** Spleen not much enlarged, but tubercular; liver, very much affected; mesenteric glands enlarged; early tubercle of the lungs. Microscopic examination shows tubercle bacilli.				
1 do. -	Do. -	Do. -	Died 213 -	**Tubercular.** Very similar to the foregoing. Microscopic examination, tubercle bacilli found.				
4								
1 guinea-pig	**30** minutes -	12 = 2½ cc. - -	Died 80 -	**Tubercular.** Several large white nodules in the spleen; one very large patch and several smaller ones in the liver; gland in the hilus of the liver and mediastinal glands tubercular; bronchial glands enlarged; several patches of tubercle in the lungs. Microscopic examination, tubercle bacilli found.				
1 do. -	Do. -	Do. - -	Died 63 -	**Tubercular.** Well-marked tubercle of the spleen and liver; glands in hilus of liver, and mesenteric glands affected; bronchial, mediastinal and cervical glands all tubercular.				
1 do. -	Do. -	Do - -	Killed 89 -	Nil.				
3								
1 guinea-pig	**30** minutes -	15 = 2½ cc. - -	Killed 74 -	Nil.				
1 do. -	Do. -	17 = 1 cc. - -	Killed 66 -	Nil.				
1 do. -	Do. -	Do. -	Died 38 -	Nil.				
3								
1 guinea-pig	**45** minutes -	12 = 2½ cc. - -	Died 47 -	Nil.				
1 do. -	Do. -	11, 12 = 4 cc. -	Killed 123 -	Nil.				
1 do. -	Do. -	7, 10, 11, 12 = 10 cc. -	Died 128 -	Nil.				
1 do. -	Do. -	12 = 2½ cc. - -	Died 76 -	**Tubercular.** Spleen, pancreas and liver all tubercular; gland in the hilus of the liver, mesenteric glands and diaphragm also affected; mediastinal, bronchial and cervical glands tubercular; lungs, early tubercle. Microscopic examination, tubercle bacilli found.				
4								
1 guinea-pig	**45** minutes -	17 = 1 cc. - -	Killed 67 -	**Tubercular.** Hard tubercular tissue (scar-like tissue) in the liver; mesenteric glands tubercular, though only slightly enlarged. Microscopic examination, tubercle bacilli found.				
1 do. -	Do. -	Do. -	Died 42 -	Nil.				
1 do. -	Do. -	Do. - -	Killed 67 -	**Tubercular.** Early tubercle in mesenteric glands only.				
3								

TABLE CVI.—*continued.*

Injection Experiments with Milk to which manifestly Tubercular Material had been added, Heated at 65° C. (149° F.)—*cont.*

Control Injection Experiments—*cont.*

No. of Animals.	Time Heated.	Intraperitoneal Injection.	Killed or Died. No. of Days.	Post-mortem Examination and Remarks.	No. of Animals.	Intraperitoneal Injections.	Killed or Died. No. of Days.	Post-mortem Examination and Remarks.
1 guinea-pig	**1** hour -	1 = 2½ cc. -	Died 31 -	Nil.				
1 do. -	Do. -	2, 3 = 10 cc. -	Died 105 -	Nil.				
1 do. -	Do. -	2, 3, 7 = 15 cc. -	Died 119 -	Nil.				
3								
1 guinea-pig	**1** hour -	12 = 2½ cc. -	Died 80 -	**Tubercular.** Glands in the groin enlarged and pigmented; in the spleen are numerous large white nodules, which contain purulent material; one large white nodule in the liver; cœliac glands enlarged; mediastinal and bronchial glands not markedly affected; several grey tubercular points in the lungs. Microscopic examination, tubercle bacilli found.				
1 do. -	Do. -	Do. -	Died 48 -	**Tubercular.** Spleen and cœliac glands tubercular; mediastinal and bronchial glands caseous; lungs tubercular. Microscopic examination, tubercle bacilli found.				
1 do. -	Do. -	Do. -	Killed 89 -	Nil.				
3								
1 guinea-pig	**1** hour -	17 = 1 cc. -	Killed 67 -	Nil.				
1 do. -	Do. -	Do -	Died 38 -	Nil.				
1 do. -	Do. -	Do. -	Died 38 -	Nil.				
3								
1 guinea-pig	**1½** hours -	17 = 1 cc. -	Killed 67 -	Nil.				
1 do. -	Do. -	Do. -	Killed 67 -	Nil.				
1 do. -	Do. -	Do. -	Killed 67 -	Nil.				
3								
1 guinea-pig	**2** hours -	3 = 5 cc. -	Died 42 -	Nil.				
1 do. -	Do. -	10 = 1 cc. -	Killed 75 -	**Tubercular.** Large cartilaginous nodules in the spleen; two large white nodules, each about the size of a large bean, in the liver; mesenteric glands very tubercular; mediastinal and bronchial glands and lung all distinctly tubercular. Microscopic examination, tubercle bacilli found.				
1 do. -	Do. -	12 = 2½ cc. -	Killed 79 -	Nil.				
1 do. -	Do. -	10 = 1 cc. -	Killed 75 -	Nil.				
4								

TABLE CVI.—*continued.*

Injection Experiments with Milk to which manifestly Tubercular Material had been added. Heated at 65° C. (149° F.)—*cont.*

Control Injection Experiments—*cont.*

No. of Animals.	Time Heated.	Intraperitoneal Injections.	Killed or Died. No. of Days.	Post-mortem Examination and Remarks.	No. of Animals.	Intraperitoneal Injections.	Killed or Died. No. of Days.	Post-mortem Examination and Remarks.
1 guinea-pig	**2** hours	17 = 1 cc.	Killed 66	Nil.				
1 do.	Do.	Do.	Died 35	**Tubercular.** Spleen and liver greatly enlarged and tubercular; mesenteric, mesocolic, cœliac, and deep inguinal glands, poststernal and mediastinal glands, bronchial glands and lungs, and glands in neck, all tubercular. Microscopic examination, tubercle bacilli found.				
1 do.	Do.	Do.	Killed 66	Nil.				
3								
1 guinea-pig	**3** hours	15 = 2½ cc.	Died 31	Nil.				
1 do.	Do.	Do.	Killed 74	**Tubercular.** Liver covered with numerous patches of scar-like tubercular tissue. No tubercle elsewhere. Microscopic examination, tubercle bacilli found.				
1 do.	Do.	15 = 5 cc.	Killed 74	Nil.				
3								
1 guinea-pig	**3** hours	17 = 1 cc.	Killed 66	Nil.				
1 do.	Do.	Do.	Killed 66	Nil.				
1 do.	Do.	Do.	Killed 66	Nil.				
3								
1 guinea-pig	**4** hours	4 = 5 cc.	Died 78	Nil.				
1 do.	Do.	Do.	Died 81	Nil.				
1 do.	Do.	Do.	Died 91	Nil.				
3								
1 guinea-pig	**8** hours	3 = 5 cc.	Died 28	Nil. Small abscess in liver, near gall bladder, otherwise normal. Microscopic examination, cocci in chains, but no tubercle bacilli.				
1 do.	Do.	3, 5 = 10 cc.	Died 90	Nil.				
1 do.	Do.	Do.	Died 90	Nil.				
3								
1 guinea-pig	**8** hours	3 = 5 cc.	Died 3	Too early to show tubercle.				
1 do.	Do.	Do.	Died 10	Do.				
1 do.	Do.	Do.	Died 27	Nil.				
3								

TABLE CVII.

Experiments with Milk to which manifestly Tubercular Material had been added, exposed to a Temperature of 70° C. (158° F.)

Materials used.

(1.) Tubercular lung of Cow No. 12 + sound milk.
Control experiments { **Injection, 3** guinea pigs, **2 Tubercular,** 1 nil. / **Feeding, 3** guinea pigs. Nil.

(2.) Milk from Cow No. 27 + tubercular organs of guinea pigs + sound milk.
Control experiments.—**Feeding, 3** guinea pigs, **3 Tubercular.**

(3.) Tubercular milk from Cow No. 25. Used for injection experiments by itself.
Control experiments.—**Injection, 3** guinea pigs, **2 Tubercular,** 1 died too early.
Tubercular milk from Cow No. 25. 300 cc. + tubercular liver and spleens of guinea pigs + sound milk. Used for feeding.
Control experiments.—**Feeding, 3** guinea pigs, **2 Tubercular.** 1 died too early to show tubercle.

(4.) Tubercular milk from Cow No. 25 + an equal quantity of sound milk.

(5.) Tubercular milk from Cow No. 25, 2,700 cc. + 1,300 cc. sound milk.

(5*a*.) Tubercular organs of a pig and several guinea pigs + sound milk.
Control experiments.—**Injection, 3** guinea pigs, **2 Tubercular.** 1 died too early to show tubercle.

(6.) Tubercular livers, spleens, lungs, and glands of three highly tubercular guinea pigs + sound milk.
Control experiments.—**Injection, 3** guinea pigs, **3 Tubercular.**

(7.) Tubercular human lung + sound milk.
Control experiments.—**Feeding, 3** guinea pigs, **1 Tubercular,** 1 nil. 1 died too early to show tubercle. 1 cat, **tubercular.**

(8.) Tubercular human lung + sound milk.
Control experiments.—**Feeding, 3** guinea pigs, **1 Tubercular.** 2 died too early to show tubercle.

(9.) Tubercular lungs and glands of Cow No. 25 + sound milk.
Control experiments { **Feeding, 3** guinea pigs, **3 Tubercular.** / **Injection, 3** guinea pigs, **2 Tubercular.** 1 died too early to show tubercle.

(10.) Same material as above.

(11.) Tubercular human lung + sound milk.
Control experiments.—**Feeding, 3** guinea pigs, **2 Tubercular,** 1 nil.

(12.) Tubercular lung from Cow No. 33 + sound milk.
Control experiment.—**Feeding, 1 Pig Tubercular.**

(13.) Same material as above.

(14.) Tubercular udder received from Birkenhead.

Feeding Experiments with Milk to which manifestly Tubercular Material had been added, Heated to 70° C. (158° F.)

No. of Animals.	Time Sterilised.	Number of Material and Amount of Feedings.	Killed or Died. No. of Days.	Post-mortem Examinations and Remarks.
1 guinea-pig	Heated to **70°** C.	9, 10 = 25 cc.	Died 9	Too early to show tubercle.
1 do.	Do.	9, 10, 11 = 150 cc.	Died 47	Nil.
1 do.	Do.	Do.	Killed 107	Nil.
3				
1 guinea-pig	Heated to **70°** C.	13 = 200 cc.	Died 61	Nil.
1 do.	Do.	Do.	Killed 89	Nil.
1 do.	Do.	Do.	Killed 89	Nil.
3				
1 guinea-pig	**2½** minutes	1, 2 = 80 cc.	Died 84	Nil.
1 do.	Do.	1, 2, 3, 4, 5, 8, 9, 10, 11 = 658 cc.	Killed 263	Nil.
1 do.	Do.	Do.	Killed 263	Nil.
3				

Control Feeding Experiments.

No. of Animals.	Number of Material and Amount of Feedings.	Killed or Died. No. of Days.	Post-mortem Examination and Remarks.
1 guinea-pig	1 = 50 cc.	Died 72	Nil.
1 do.	Do.	Died 86	Nil.
1 do.	Do.	Died 130	Nil.
3			
1 guinea-pig	2 = 50 cc.	Died 69	**Tubercular.** Early tubercle of the spleen.
1 do.	Do.	Died 136	**Tubercular.** One suspicious white point in the spleen. Mesenteric glands contain cheesy pus, in which, on microscopic examination, tubercle bacilli were found. No other organs or parts affected.
1 do.	Do.	Killed 202	**Tubercular.** One or two tubercular nodules in the spleen; a nodule also found in the capsule of the kidney; glands at hilus of liver enlarged, and contain caseo-purulent material. Mesocolic and cœliac glands tubercular, containing caseo-purulent matter. Intestines very much ulcerated. One or two tubercular nodules in the lungs. Microscopic examination, tubercle bacilli found.
3			

TABLE CVII.—*continued.*

Feeding Experiments with Milk to which manifestly Tubercular Material had been added, Heated to 70° C. (158° F.)—*cont.*

No. of Animals.	Time Sterilised.	Number of Material and Amount of Feedings.	Killed or Died. No. of Days.	Post-mortem Examinations and Remarks.
1 guinea-pig	**5** minutes	1, 2, 3 = 107 cc.	Killed 126	Nil.
1 do.	Do.	9, 10, 11 = 108 cc.	Killed 107	Nil.
1 do.	Do.	1, 2, 3, 4, 5, 8=524cc.	Died 197	Nil.
1 do.	Do.	9, 10, 11 = 108 cc.	Died 97	**Tubercular.** Mesocolic, cœliac glands, and glands at the hilus of the liver tubercular. Spleen and liver both showed wall-marked and advanced tuberculosis. Mediastinal, bronchial, and cervical glands and lungs all markedly affected with advanced tuberculosis. Microscopic examinations, tubercle bacilli found.
1 do.	Do.	1, 2, 3, 4, 5, 8, 9, 10, 11 = 470 cc.	Killed 263	Nil.
5				
1 pig	**7½** minutes	12, 13 = 4,000 cc.	Killed 85	**Tubercular.** One or two suspicious points in the tonsil. Cervical glands, on both sides, tubercular; mediastinal, poststernal, and bronchial glands tubercular. Miliary tubercle nodules in the lung. Tubercle on ribs in form of "grapes," especially well marked on the right side. Lymphatics of diaphragm tubercular. Numerous small tubercle nodules in the liver. A few raised nodules in the spleen. Glands in hilus of liver and hilus of stomach showed early tubercle. Mesocolic and mesenteric glands caseating. Deep inguinal glands not tubercular. Intestines and other organs apparently normal. Microscopic examinations, tubercle bacilli found.
1 guinea-pig	**10** minutes	1, 2, 3 = 107 cc.	Died 144	Nil.
1 do.	Do.	8, 9, 10, 11=108 cc.	Killed 118	Nil.
1 do.	Do.	1, 2, 3, 4, 5, 7, 8, 9= 823 cc.	Died 118	Nil.
1 do.	Do.	8, 9, 10, 11 = 108 cc.	Killed 211	Nil.
1 do.	Do.	1, 2, 3, 4, 5, 7=650 cc.	Died 118	Nil.
5				
1 guinea-pig	**15** minutes	1, 2, 3, 4 = 175 cc.	Died 88	Nil.
1 do.	Do.	Do.	Died 144	Nil.
1 do.	Do.	1, 2, 3, 4, 5, 7, 8, 9, 10, 11 = 1,000 cc.	Died 314	Nil.
3				
1 pig	**15** minutes	8, 9, 11, 14=1,400 cc.	Died 91	**Tubercular.** A few nodules of yellow tubercle in the liver. A single nodule in the spleen. Bronchial and posterior mediastinal glands caseous. Lungs show miliary tubercles throughout; one of these caseating. Other glands and organs normal. Microscopic examinations, tubercle bacilli found.

Control Feeding Experiments—*cont.*

No. of Animals.	Number of Material and Amount of Feedings.	Killed or Died. No. of Days.	Post-mortem Examination and Remarks.
1 guinea-pig	3 = 70 cc.	Died 5	Too early to show tubercle.
1 do.	Do.	Killed 119	**Tubercular.** Spleen contained numerous large tubercular nodules. A number of fine tubercular points in liver. Mesenteric glands enormously enlarged and tubercular. Intestines extensively ulcerated. Anterior mediastinal and bronchial glands enlarged and tubercular. A number of minute tubercular granulations in both lungs. Microscopic examination, tubercle bacilli found.
1 do.	Do.	Killed 119	**Tubercular.** Very similar condition to the above. Microscopic examination, tubercle bacilli found.
3			
1 guinea-pig	7 = 33 cc.	Died 24	Too early to show tubercle.
1 do.	Do.	Killed 129	**Tubercular.** Spleen enormously enlarged, tubercular. Several distinct, yellow, tubercular patches in the liver. Pancreas studded with tubercular nodules. Mesocolic and cœliac glands tubercular. Tubercular ulceration of the intestines. Glands in thorax and lungs only slightly affected. Microscopic examination, tubercle bacilli found.
1 do.	Do.	Killed 129	Nil.
3			
1 cat	7 = 750 cc.	Killed 77	**Tubercular.** Two small tubercular patches in the cortex of one of the mesenteric glands, none in medulla. All other organs normal. Microscopic examination, tubercle bacilli found.

TABLE CVII.—*continued.*

Feeding Experiments with Milk to which manifestly Tubercular Material had been added, Heated to 70° C. (158° F.)—*cont.*

No. of Animals.	Time Sterilised.	Number of Material and Amount of Feedings.	Killed or Died. No. of Days.	Post-mortem Examination and Remarks.
1 kitten	**15** minutes	11 = 200 cc.	Died 7	Too early to show tubercle.
1 do.	Do.	14 = 500 cc.	Killed 88	Nil.
1 guinea-pig	**20** minutes	1, 2, 3, 4, 5, 7, 8, 9, 10, 11 = 600 cc.	Died 179	Nil.
1 do.	Do.	Do. = 600 cc.	Killed 313	Nil.
1 do.	Do.	1, 2, 3, 4, 5, 7, 8 = 490 cc.	Died 197	Nil.
3				
1 guinea-pig	**30** minutes	1, 2, 3, 4 = 170 cc.	Died 93	Nil.
1 do.	Do.	1, 2, 3, 4, 5, 7, 8, 9, 10, 11 = 600 cc.	Killed 202	Nil. Gland at root of lung pigmented.
1 do.	Do.	Do. = 600 cc.	Killed 202	Nil.
3				
1 kitten	**30** minutes	11 = 200 cc.	Killed 119	Nil.
1 do.	**30** minutes	14 = 600 cc.	Killed 88	Nil.
1 pig	**30** minutes	8, 9, 11, 14=1400 cc.	Died 43	Nil. Tonsil and adjacent pharynx studded with small ulcers, in the floor of which are yellow points, but the surrounding glands in the neck and under the jaw are not tubercular; intestines, one patch near cæcum ulcerating, in floor of ulcer are yellow points; there are also greyish points in Peyer's patches, which, however, are not tubercular; a hard, ulcerated patch was found in the cæcum; mesenteric glands slightly enlarged, but not tubercular; spleen, liver, and lungs normal. Microscopic examination. Bacterial necrosis. No tubercular structure or tubercle bacilli could be made out.
1 pig	**45** minutes	8, 9, 11, 14=1400 cc.	Killed 117	**Tubercular.** Early tubercle of the bronchial and posterior mediastinal glands in which are about half a dozen small, yellow, tubercle nodules; other organs and parts apparently normal. Microscopic examination, tubercle bacilli found, as well as other bacilli and cocci.
1 guinea pig	**45** minutes	8, 9, 10, 11 = 150 cc.	Killed 118	Nil.
1 do.	Do.	8 = 30 cc.	Died 9	Too early to show tubercle.
1 do.	Do.	9, 10, 11 = 150 cc.	Killed 109	Nil.
3				

Control Feeding Experiments—*cont.*

No. of Animals.	Number of Material and Amount of Feedings.	Killed or Died. No. of Days.	Post-mortem Examinations and Remarks.
1 guinea-pig	8 = 100 cc.	Died 7	Too early to show tubercle.
1 do.	Do.	Died 7	Do. do.
1 do.	Do.	Died 33	**Tubercular.** Early tubercle of the mesenteric glands. Patches of tubercular ulceration in the large intestine, especially near the cæcum. Other organs normal.
3			
1 pig	8, 9, 11, 14=1,400 cc.	Killed 117	**Tubercular.** The animal is emaciated; the sub-maxillary and submental glands and glands in the region of the parotid are enormously enlarged, tubercular, and contain caseo-purulent material. The tonsils are distinctly scarred, and there are one or two yellow points in their substance, whilst the surrounding lymphatic glands in the neck and the chain of glands extending to the upper margin of the scapula are all tubercular, as are also the anterior and posterior mediastinal, the poststernal and the bronchial glands; the lungs are distinctly affected; the spleen is also markedly tubercular; early grey granules on the liver; mesenteric, mesocolic, and cœliac glands and glands at the hilus of the liver and along both curvatures of the stomach are greatly enlarged and tubercular. There is no ulceration of the intestines, which were, however, filled with lumbricoid worms. In this case the infection has evidently been by the tonsils, and so to the glands in the the neck, from which the disease has extended downwards. Microscopic examination, tubercle bacilli found.
1 guinea-pig	9 = 25 cc.	Died 33	**Tubercular.** Spleen slightly enlarged and covered with tubercular nodules; early tubercle of the liver; mesenteric glands enlarged, indurated, tubercular; glands in the chest wall slightly enlarged, tubercular; the lungs are studded with greyish yellow tubercle nodules; other organs and parts normal. Microscopic examination, tubercle bacilli found.
1 do	Do.	Killed 56	**Tubercular.** Glands under the jaw and in the neck enlarged and tubercular; the lungs are adherent to the chest wall, and contain large masses of tubercle; the poststernal mediastinal and bronchial glands are all caseous; spleen and liver markedly affected; mesenteric glands enormously enlarged; intestines ulcerated, tubercular.
1 do.	Do.	Killed 56	**Tubercular.** In a very similar condition to above. Microscopic examination, tubercle bacilli found.
3			

TABLE CVII.—*continued.*

Feeding Experiments with Milk to which manifestly Tubercular Material had been added, Heated to 70° C. (158° F.)—*cont.*

No. of Animals.	Time Sterilised.	Number of Material and Amount of Feedings.	Killed or Died. No. of Days.	Post-mortem Examination and Remarks.
1 guinea-pig	**1** hour	3, 4, 5, 7, 8 = 410 cc.	Died 102	Nil.
1 do.	Do.	3, 4, 5, 7, 8, 9 = 520 cc.	Died 108	Nil.
1 do.	Do.	3, 4, 5, 7, 8, 9, 10, 11, = 770 cc.	Killed 160	Nil.
3				
1 guinea-pig	**1½** hours	3, 4, 5, 6, 7, 8, 9, 10, 11 = 510 cc.	Killed 213	Nil.
1 do.	Do.	Do.	Killed 213	Nil.
1 do.	Do.	Do.	Died 205	Nil.
3				
1 guinea-pig	**2** hours	3, 4, 5, 6, 7, 8, 9, 10, 11 = 510 cc.	Died 116	Nil.
1 do.	Do.	Do.	Killed 213	Nil.
1 do.	Do.	Do.	Killed 213	Nil.
3				

Control Feeding Experiments—*cont.*

No. of Animals.	Number of Material and Amount of Feedings.	Killed or Died. No. of Days.	Post-mortem Examination and Remarks.
1 guinea-pig	11 = 25 cc.	Killed 104	Nil.
1 do.	Do.	Killed 104	**Tubercular.** Animal much emaciated; pharynx scarred, and marked with one or two yellow points; glands around distinctly tubercular; submaxillary and parotid glands purulent and tubercular; glands above the scapula tubercular, but those in the axilla are normal; the anterior and posterior mediastinal and bronchial glands are tubercular; the lungs are markedly affected; spleen tubercular; grey granules of early tubercle in liver; glands at hilus of liver and at lesser curvature of stomach, cœliac, mesenteric, and mesocolic glands all markedly tubercular; no tubercle found in the intestines. The infection in this case appears to be through the adenoid tissue of the pharynx and so to the glands of the neck. A number of small tubercular nodules in the spleen; several patches in the liver; mediastinal glands and lungs normal. Microscopic examination, tubercle bacilli found.
1 do.	Do.	Killed 104	**Tubercular.** Very similar to above, but not so far advanced. Microscopic examination, tubercle bacilli found.
3			
1 pig	12 = 1,000 cc.	Died 42	**Tubercular.** Numerous small ulcers and nodules of yellow tubercle in each tonsil; sublingual and submental glands caseous, and from these extend a chain of caseous glands to each axilla; anterior and posterior mediastinal and bronchial glands enlarged and caseous; the lungs show a few grey miliary tubercles, marked consolidation of the left lung; spleen infiltrated with miliary tubercles throughout; numerous yellow fatty patches in the liver, but no tubercle; cœliac, mesocolic, and mesenteric glands all enlarged and caseous; several occluded follicles in the large intestine—tubercular; tubercular ulceration of all the Peyer's patches in the small intestine, with numerous solitary follicles, enlarged and tubercular, surrounding them; the small tubercular points are about the size of a pin head. Microscopic examination, numerous tubercle bacilli found in the lung.

TABLE CVII.—*continued.*

Injection Experiments with Milk to which manifestly Tubercular Material had been added, Heated at 70° C. (158° F.).

No. of Animals.	Time Sterilised.	Intraperitoneal Injection.	Killed or Died. No. of Days.	Post-mortem Examination and Remarks.
1 guinea-pig	Heated to **70°** C.	5*a*, 6 = 6½ cc.	Died 23	Nil. Liver adherent to diaphragm and spleen.
1 do	Do.	Do.	Died 23	Nil. Great inflammation of abdominal organs.
1 do.	Do	5*a*, 8, = 8 cc.	Died 38	Nil.
1 do.	Do.	9 = 1 cc.	Killed 149	Nil.
4				

Control Injection Experiments.

No. of Animals.	Intraperitoneal Injection.	Killed or Died. No. of Days.	Post-mortem Examination and Remarks.
1 guinea-pig	1 = 2 cc.	Died 33	**Tubercular.** Spleen only slightly affected; abscess in the hilus of the liver, which contained soft yellow pus, and at this point the intestines were attached to the liver and anterior abdominal wall. Other organs normal. Microscopic examination, tubercle bacilli.
1 do.	Do.	Killed 54	**Tubercular.** Several tubercular patches found in the liver and a single nodule in the spleen.
1 do.	Do.	Killed 127	Nil.
3			

TABLE CVII.—*continued.*

Injection Experiments with Milk to which manifestly Tubercular Material had been added, Heated at 70° C. (158° F.)—*cont.*

No. of Animals.	Time Sterilised.	Intraperitoneal Injection.	Killed or Died. No. of Days.	Post-mortem Examinations and Remarks.
1 guinea-pig	**2½** minutes	5*a*, 6, 8 = 8 cc.	Died 39	Nil.
1 do.	Do.	Do.	Died 142	Nil.
1 do.	Do.	Do.	Died 33	Nil.
1 do.	Do.	9 = 1 cc. (subcutaneously).	Died 107	**Tubercular.** Hard white tubercular nodules in the spleen and liver; large grey gelatinous patches in the lungs; bronchial glands tubercular. Microscopic examination, tubercle bacilli found.
4				
1 guinea-pig	**2½** minutes	1, 2 = 7½ cc.	Killed 84	Nil.
1 do	Do.	1, 2, 3, 4 = 17½ cc.	Died 149	Nil. Liver fatty.
1 do.	Do.	Do.	Killed 157	**Tubercular.** Large abscess close to stomach; matting together of the abdominal organs. Microscopic examination shows tubercle bacilli, cocci, and short rods.
3				
1 guinea-pig	**2½** minutes	10 = 1½ cc.	Killed 101	Nil.
1 do.	Do.	Do.	Killed 101	Nil.
1 do.	Do.	Do.	Killed 101	Nil.
3				
1 guinea-pig	**5** minutes	5*a*, 6, 7 = 8½ cc.	Died 22	Nil.
1 do.	Do.	Do.	Died 22	Nil.
1 do.	Do.	Do.	Died 22	Nil.
3				
1 guinea-pig	**5** minutes	10 = 1½ cc.	Died 41	Nil.
1 do.	Do.	Do.	Killed 101	Nil.
1 do.	Do.	Do.	Killed 101	Nil.
3				

Control Injection Experiments—*cont.*

No. of Animals.	Intraperitoneal Injection.	Killed or Died. No. of Days.	Post-mortem Examination and Remarks.
1 guinea pig	3 = 5 cc.	Killed 13	Died too early to show tubercle.
1 do.	Do.	Died 33	**Tubercular.** Well-marked tubercle over the wall of the abdomen and throughout the mesenteric lymphatic system; many fine points in the liver and spleen; early tubercle in the lungs; glands at the root of the lung also affected; the pleural and abdominal cavities filled with serous fluid. Microscopic examination, tubercle bacilli found.
1 do.	Do.	Died 40	**Tubercular.** Very similar condition to the foregoing, but more advanced. Microscopic examination, tubercle bacilli found.
3			
1 guinea-pig	5*a*, = 1½ cc.	Died 15	Too early to show tubercle.
1 do.	Do.	Died 19	**Tubercular.** Tubercle on the peritoneal wall; omentum, spleen, and glands at hilus of liver also affected. Microscopic examination, tubercle bacilli found.
1 do.	Do.	Died 19	**Tubercular.** Pancreas only affected: in this there were several tubercular nodules. Microscopic examination, tubercle bacilli found.
3			
1 guinea-pig	6 = 1 cc.	Died 26	**Tubercular.** Well-marked tuberculosis of the spleen, pancreas, and liver. Tubercle well-marked on the wall of the abdomen; deep inguinal and cœliac glands tuberclar; early tubercle of the lungs; other organs and parts normal; microscopic examination, Tubercle bacilli found.
1 do.	Do.	Died 27	**Tubercular.** Very similar to the above. On microscopic examination, tubercle bacilli found.
1 do.	Do.	Died 39	**Tubercular.** Spleen tubercular but not much enlarged; scattered patches of tubercle in the liver; abdominal wall markedly affected; early gelatinous tubercle in the lungs; no other organs affected. Microscopic examination, tubercle bacilli found.
3			
1 guinea-pig	9 = 1 cc.	Killed 56	**Tubercular.** Spleen enlarged and tubercular; a number of early tubercular patches throughout the substance of the liver; gland in hilus of liver enlarged and tubercular; cervical glands, and those at the root of lung indurated, enlarged, tubercular; early tubercle of the lungs in which, on microscopic examination, tubercle bacilli were found.
1 do.	Do	Died 4	Too early to show tubercle.
1 do.	Do.	Died 18	**Tubercular.** A large abscess had formed at the seat of inoculation; a gland in the groin on the same side enlarged and suppurating; the gland on the opposite side similarly affected, but in a lesser degree; very early tubercle of the spleen and liver. Microscopic examination, tubercle bacilli found.
3			

Some controls as above for No. 10 injection.

TABLE CVII.—*continued.*

Injection Experiments with Milk to which manifestly Tubercular Material had been added, Heated at 70° C. (158° F.)—*cont.*

Control Injection Experiments—*cont*

No. of Animals.	Time Sterilised.	Intraperitoneal Injection.	Killed or Died. No. of Days.	Post-mortem Examination and Remarks.	No. of Animals.	Intraperitoneal Injection.	Killed or Died. No. of Days.	Post-mortem Examination and Remarks.
1 guinea-pig	**5** minutes	1, 2 = 7½ cc.	Killed 84	**Tubercular.** One of the mesenteric glands apparently tubercular; spleen very considerably enlarged, and scattered over it are a number of grey miliary tubercles. Other organs normal.				
1 do.	Do.	1, 2, 3 = 12½ cc.	Died 105	Nil.				
1 do.	Do.	Do.	Died 105	Nil.				
3								
1 guinea-pig	**10** minutes	1, 2 = 7½ cc.	Killed 84	**Tubercular.** Small tubercular nodules in the capsule of the spleen; small tubercular abscess at the junction of one of the ribs with its costal cartilage.				
1 do	Do.	1, 2, 3 = 12½ cc.	Died 105	Nil.				
1 do.	Do.	1, 2, 3, 4 = 17½ cc.	Killed 157	Nil.				
3								
1 guinea-pig	**10** minutes	5*a*, 6 = 6½ cc.	Died 14	**Tubercular.** On the surface of the abdominal wall are several tubercle nodules full of yellow pus; one yellow patch on the liver, where it had become attached to the abdominal wall; pancreas enlarged and hard, and on section found to be full of pus; spleen and lungs apparently normal. Microscopic examination, tubercle bacilli found.				
1 do.	Do.	Do.	Died 14	**Tubercular.** Abdominal cavity filled with serous fluid; abdominal wall had several tubercle nodules full of yellow pus; large abscess in liver; spleen somewhat enlarged, but not apparently tubercular; lungs normal.				
1 do.	Do.	5*a*, 6, 7 = 8¼ cc.	Died 22	Nil.				
3								
1 guinea-pig	**10** minutes	10 = 1¼ cc.	Killed 101	Nil.				
1 do.	Do.	Do.	Killed 101	Nil.				
1 do.	Do.	Do.	Killed 101	Nil. Small yellow nodule about the size of a millet seed on the surface of the liver. Microscopic examination showed no evidence of tubercle.				
3								
1 guinea-pig	**15** minutes	1 = 2½ cc.	Died 28	Nil. Liver mottled with yellow caseous patches at one point suppurating; matting together of the intestines. Microscopic examination showed abscess formation, but no tubercle bacilli could be found.				
1 do.	Do.	1, 2 = 7½ cc.	Killed 84	Nil. Lungs pigmented.				
1 do.	Do.	1, 2, 3, 4, 5 = 22½ cc.	Killed 165	**Tubercular.** Spleen enormously enlarged and tubercular; mesenteric glands slightly enlarged, tubercular. Other organs and parts normal. Microscopic examination, tubercle bacilli found.				
1 do.	Do.	2, 3, 4, 5 = 20 cc.	Killed 104	Nil.				
4								

TABLE CVII.—*continued.*

Injection Experiments with Milk to which manifestly Tubercular Material had been added, Heated at 70° C. (158° F.)—*cont.*

Control Injection Experiments—*cont.*

No. of Animals.	Time Sterilised.	Intraperitoneal Injection.	Killed or Died. No. of Days.	Post-mortem Examination and Remarks.	No. of Animals.	Intraperitoneal Injection.	Killed or Died. No. of Days.	Post mortem Examination and Remarks.
1 guinea-pig	**15** minutes	5*a*, 6, 7, 8 = 10 cc.	Died 28	Nil.				
1 do.	Do.	Do.	Died 32	Nil.				
1 do.	Do.	Do.	Died 32	Nil.				
3								
1 guinea-pig	**15** minutes	10 = 1½ cc.	Died 14	Too early to show tubercle.				
1 do.	Do.	Do.	Died 16	Do. do.				
1 do.	Do.	Do.	Died 107	Nil.				
3								
1 guinea-pig	**20** minutes	1, 2 = 7½ cc.	Died 78	Nil.				
1 do.	Do.	1, 2, 3 = 12½ cc.	Killed 165	Nil.				
1 do.	Do.	1, 2, 3, 4, 5, 6, 7 = 29½ cc.	Died 189	Nil.				
3								
1 guinea-pig	**20** minutes	5*a*, 6, 7 = 8½ cc.	Died 22	Nil.				
1 do.	Do.	Do.	Died 22	Nil.				
1 do.	Do.	5*a*, 6, 7, 8 = 10 cc.	Died 33	Nil.				
3								
1 guinea-pig	**20** minutes	10 = 1½ cc.	Died 6	Too early to show tubercle.				
1 do.	Do.	Do.	Died 95	Nil.				
1 do.	Do.	Do.	Killed 107	Nil.				
3								
1 guinea-pig	**30** minutes	2 = 5 cc.	Killed 23	**Tubercular.** Spleen contains purulent nodules which were probably tubercular. Microscopic examination showed presence of tubercle bacilli.				
1 do.	Do.	Do.	Died 11	Nil.				
1 do.	Do.	2, 3, 4, 5 = 20 cc.	Killed 105	Nil.				
1 do.	Do.	3, 4, 5, 6 = 20 cc.	Died 77	Nil. Abscess in the hilus of the liver. Microscopic examination, showed presence of diplococci, but no tubercle bacilli.				
4								

TABLE CVII.—*continued.*

Injection Experiments with Milk to which manifestly Tubercular Material had been added, Heated at 70° C. (158° F.)—*cont.*

Control Injection Experiments—*cont.*

No. of Animals.	Time Sterilised.	Intraperitoneal Injection.	Killed or Died. No. of Days.	Post-mortem Examinations and Remarks.	No. of Animals.	Intraperitoneal Injection.	Killed or Died. No. of Days.	Post-mortem Examination and Remarks.
1 guinea-pig	**30** minutes	9 = 1 cc.	Died 21	Nil. Gland under skin at point of inoculation enlarged and hard; small yellow points at the surface, but these are not like ordinary tubercles; one or two yellow nodules in the lymphatics of the omentum; lungs congested, several grey points on surface. On microscopic examination the liver was found to be fatty but no trace of tubercular structure or other evidence of the presence of tubercle could be found.				
1 do.	Do.	Do.	Killed 115	Nil.				
1 do.	Do.	Do.	Killed 115	**Tubercular.** Right inguinal gland slightly enlarged; a firm light yellow nodule in liver. Microscopic examination, tubercle bacilli found; a necrosed area also found in the liver.				
3								
1 guinea-pig	**45** minute	8, 9 = 2½ cc.	Killed 126	Nil.				
1 do.	Do.	5A, 6, 7, 8 = 10 cc.	Died 30	Nil.				
1 do.	Do.	8, 9 = 2½ cc.	Killed 126	Nil.				
1 do.	Do.	5A, 6, 7, 8 = 10 cc.	Died 32	Nil.				
4								
1 guinea-pig	**1** hour	5A, 6 = 6½ cc.	Died 11	Nil.				
1 do.	Do.	5A, 6. 8 = 8 cc.	Died 33	Nil. Abdominal organs adherent to wall of abdomen.				
1 do.	Do.	Do.	Died 33	Nil.				
3								
1 guinea-pig	**1** hour	3 = 5 cc.	Died 11	Nil. Liver, several white patches, Microscopic examination: Section shows remains of an abscess which is apparently undergoing a process of resolution.				
1 do.	Do.	Do.	Died 37	Nil.				
1 do.	Do.	3, 4, 5, 6 = 20 cc.	Died 97	Nil.				
3								
1 guinea-pig	**1½** hours	3 4, 5, 6, 7 = 22 cc.	Died 86	Nil.				
1 do.	Do.	Do.	Died 101	Nil.				
1 do.	Do.	8, 9 = 2½ cc.	Killed 72	Nil.				
3								
1 guinea-pig	**2** hours	3. 4, 5, 6, 7, 8 = 23½ cc.	Died 115	Nil.				
1 do.	Do.	3, 4 = 10 cc.	Died 42	Nil. Liver, one or two grey points. Microscopic examination, section shows necrosis.				
1 do.	Do.	8. 9 = 2½ cc.	Killed 118	Nil.				
1 do.	Do.	3, 4, 5, 6 7 = 22 cc.	Died 86	Nil. Liver, one small point. Microscopic examination, section shows necrotic patch.				
1 do	Do.	8, 9 = 2½ cc.	Died 84	Nil. Enlarged heart.				
5								

TABLE CVIII.

Experiments with Milk to which manifestly Tuberculous Material had been added, exposed to a temperature of 75° C. (167° F.)

Materials used.

(1.) Material. Tubercular glands from guinea-pig + sound milk.
Control Experiments.—**Injection, 2** guinea-pigs, **2 tubercular.**

(2.) Material. Tubercular lung of cow + tubercular milk from Cow No. 25 + sound milk.
Control Experiments.—**Feeding, 3** guinea pigs, 1 died too early to show tubercle, **2 tubercular.**

(3.) Material. Tubercular organs of pig — spleen, lung, liver, glands and pleura + sound milk.
Control Experiments.—**Injection, 3** guinea-pigs, 1 died too early to show tubercle, **2 tubercular.**

(4.) Material. Tubercular human lung + sound milk.
Control Experiments.—**Feeding, 2** guinea-pigs and **1** cat. **1** guinea-pig **tubercular,** 2 nil, and **1** cat **tubercular.**

(5.) Material. Tubercular udder received from Birkenhead + sound milk.

(6.) Material. Tubercular human lung + sound milk.
Control Experiments.—**Feeding, 3** guinea-pigs, 2 died too early to show tubercle **1 tubercular.**

(7.) Material. Tubercular lung and glands from cow No. 25 + sound **milk**
Control Experiments { **Feeding, 3** guinea-pigs, **3 tubercular.** **Injection, 3** guinea-pigs, **2 tubercular,** 1 died too early to show tubercle.

(8.) Material. Caseous tubercular glands of Cow No. 25 + sound milk.
Control Experiments.—Same animals as those for No. 7 material.

(9.) Material. Tubercular human lung + sound milk.
Control Experiments.—**Feeding, 3** guinea-pigs, **2 tubercular,** 1 nil.

(10.) Material. Tubercular lung from cow sent from Metropolitan Cattle Market + sound milk.
Control Experiments { **Feeding, 3** guinea-pigs, **3 tubercular.** **Injection, 3** guinea-pigs, **3 tubercular.**

Feeding Experiments with Milk to which manifestly Tuberculous Material had been added, Heated at 75° C. (167° F.)

Animals.	Time Heated.	Number of Feedings and Amount.	Killed or Died. No. of Days.	Post-mortem Examination and Remarks.
1 kitten	Heated to **75°** C.	7, 8, 9, 10 = 1,250 cc.	Killed 129	Nil. Right tonsil apparently slightly enlarged. Microscopic examination showed only normal structure.
1 do. 2	Do.	10 = 300 cc.	Killed 62	Nil.
1 guinea-pig	Heated to **75°** C.	8, 9 = 170 cc.	Died 34	Nil.
1 do.	Do.	Do.	Killed 104	Nil. Liver, on anterior surface were numerous grey white nodules aggregated together. Microscopic examination showed portal infiltration and abscess.
1 do. 3	Do.	Do.	Killed 104	Nil.
1 kitten	**5** minutes	7, 8, 9 = 950 cc.	Died 59	**Tubercular.** Marked congestion of the intestines accompanied by yellow irregular swellings, with slight ulceration at apices of folds, evidently early stage of tubercular ulceration. Other organs normal.
1 pig	Do.	5, 6, 7, 9 = 1,400 cc.	Killed 117	**Tubercular.** Parotid and submental glands very much enlarged, hard, and tubercular; tonsils and pharynx normal; lungs infiltrated with tubercle, more advanced in left than in the right; glands at the root affected; ribs covered with "grapes," and diaphram studded with tubercles. The liver and spleen had numerous white nodules about the size of a pea scattered throughout them; kidneys normal; retroperitoneal, mesenteric, and cœliac glands all slightly affected; intestines normal. Microscopic examination, tubercle bacilli found.

Control Feeding Experiments.

Animals.	Number of Feedings and Amount.	Killed or Died. No. of Days.	Post-mortem Examination and Remarks.
1 guinea-pig	2 = 25 cc.	Died 5	Too early to show tubercle.
1 do.	Do.	Killed 119	**Tubercular.** A number of large tubercle nodules in the spleen; numerous grey points in the liver; mesenteric, mesocolic, and cœliac glands enormously enlarged; intestines extensively ulcerated; poststernal, posterior mediastinal, and bronchial glands enlarged and tubercular; a few tubercle points in the lungs. Microscopic examination, tubercle bacilli found.
1 do. 3	Do.	Killed 119	**Tubercular.** Very similar to above. Microscopic examination, tubercle bacilli found.
1 guinea-pig	4 = 33 cc.	Died 24	Nil.
1 do.	Do.	Killed 129	**Tubercular** Spleen enormously enlarged liver and pancreas also affected; mesenteric, mesocolic, and cœliac glands all tubercular; intestines ulcerated; several distinct yellow patches in the liver; lungs and the glands at root, of the lungs only slightly affected. Microscopic examination, tubercle bacilli found.
1 do 3	Do.	Killed 129	Nil.
1 cat	4 = 750 cc.	Killed 77	**Tubercular.** Two small tubercular patches in the cortex of one of the mesenteric glands, none in medulla; other organs normal. Microscopic examination, tubercle bacilli found.

TABLE CVIII.—*continued.*

Feeding Experiments with Milk to which manifestly Tuberculous Material had been added, Heated at 75° C. (167° F.)—*cont.*

Animals.	Time Heated.	Number of Feedings and Amount.	Killed or Died. No. of Days.	Post-mortem Examination and Remarks.
1 guinea-pig	7½ minutes	2 = 100 cc.	Died 41	**Tubercular.** Several tubercular nodules just becoming apparent in the spleen; several similar rounded points about the size of a pea in the liver; lungs normal; mesenteric glands at one or two points are enlarged, yellow, and filled with thin pus. The Peyer's patches in the intestines seemed slightly affected.
1 do.	Do.	2, 4, 8, 9 = 550 cc.	Killed 177	Nil. Mesenteric gland and gland in intestine appeared suspicious. Microscopic examination exhibited neither tubercle bacilli nor tubercular structure.
1 do.	Do.	Do.	Killed 177	Nil.
3				
1 kitten	**10** minutes	9 = 200 cc.	Died 56	**Tubercular.** Intestines, near the vermiform appendix, slightly inflamed; mesenteric glands apparently larger than usual; small ulcerations in the vermiform appendix. Microscopic examination, tubercle bacilli found.
1 pig	**10** minutes	5, 6, 7, 9 = 1,400 cc.	Died 92	**Tubercular.** Pleura covering diaphragm, parietal pleuræ, peritoneum, and mesentery all covered with tubercles; pericardium normal; numerous nodules of caseous tubercle in the spleen and liver; kidneys and pancreas normal; lungs solid with caseous miliary tubercle; bronchial and cœliac glands greatly enlarged and caseous; on the left tonsil is a small tubercular ulcer, and extending down to the left axilla is a chain of enlarged and caseous lymphatic glands; the submaxillary glands on the left side show a similar condition, as did also the anterior and posterior mediastinal glands. In the intestines are two small tubercles near the cæcum, and the mesenteric glands contain some nodules of yellow tubercle. Microscopic examination, tubercle bacilli found.
1 guinea-pig	**15** minutes	2 = 100 cc.	Died 40	Nil.
1 do.	Do.	2, 4, 8, 9 = 550 cc.	Killed 171	Nil.
1 do.	Do.	Do.	Died 163	Nil. Lungs pneumonic.
3				
1 cat	15 minutes	9 = 200 cc.	Died 58	**Tubercular.** Intestines near vermiform appendix slightly inflamed; mesenteric glands apparently enlarged and granular. In the vermiform appendix there are what seem to be small tubercular ulcerations. Microscopic examination, tubercle bacilli found.

Control Feeding Experiments—*cont.*

Animals.	Number of Feedings and Amount.	Killed or Died. No. of Days.	Post-mortem Examination and Remarks.
1 pig	5, 6, 7, 9 = 1,400 cc.	Killed 117	**Tubercular.** Spleen tubercular; grey granules just commencing in the liver; mesenteric, mesocolic, and cœliac glands, and glands in the hilus of the liver, in the lesser curvature of the stomach and along the outer curvature of the stomach, under the peritoneum, all tubercular; kidneys and pancreas normal; lungs affected, as are also the anterior and posterior, mediastinal, poststernal, and bronchial glands, and glands in the neck; submaxillary and parotid glands purulent. The tonsils are scarred and are marked by one or two yellow points; the glands around are tubercular; glands in axilla free, but those above the scapula are affected; intestines normal. Microscopic examination, tubercle bacilli found.
1 guinea-pig	6 = 100 cc.	Died 8	Too early to show tubercle.
1 do.	Do.	Died 8	Do.
1 do.	Do.	Died 24	**Tubercular.** Early tubercle of the mesenteric glands; patches of tubercular ulceration in the large intestine, especially near the cæcum; the other organs are normal.
3			
1 guinea-pig	7 = 25 cc.	Died 33	**Tubercular.** Mesenteric glands enlarged and hard; intestines apparently normal; spleen very slightly enlarged and covered with tubercle nodules; early tubercular affection of the liver; a number of greyish nodules in the lungs; glands on the chest wall slightly affected. Microscopic examination, tubercle bacilli found.
1 do.	Do.	Killed 56	**Tubercular.** Mesenteric glands enormously enlarged and intestines ulcerated; well marked tubercle of the liver and spleen; lungs adherent to the chest wall and infiltrated with large masses of tubercle; mediastinal and bronchial glands, and glands behind the sternum, under the jaw and on the neck all enlarged and tubercular. Microscopic examination, tubercle bacilli found.
do.	Do.	Killed 56	**Tubercular.** Very similar to above.
3			
1 guinea-pig	9 = 25 cc.	Killed 104	Nil.
1 do.	Do.	Killed 104	**Tubercular.** Mesenteric glands much enlarged; intestines ulcerated; a number of small nodules in the spleen; several patches of tubercle in the liver; other organs normal. Microscopic examination, tubercle bacilli found.
1 do.	Do.	Killed 104	**Tubercular.** Much the same condition as above. Microscopic examination, tubercle bacilli found.
3			

TABLE CVIII.—*continued.*

Feeding Experiments with Milk to which manifestly Tuberculous Material had been added, Heated at 75° (C. 167° F.)—*cont.*

Animals.	Time Heated.	Number of Feedings and Amount.	Killed or Died. No. of Days.	Post-mortem Examination and Remarks.
1 pig	15 minutes	5, 6, 7, 8, 9 = 1,400 cc.	Killed 117	**Tubercular.** Liver and spleen slightly affected, but cœliac glands and those in the hilus of the liver very large indeed; lungs tubercular, but the disease is here not very advanced; bronchial, poststernal, posterior and anterior mediastinal glands all affected, as are also the glands in the neck; tonsils affected on both sides, and the glands around them enlarged and caseous; intestines normal; mesenteric and mesocolic glands affected but not markedly so. Microscopic examination, tubercle bacilli found.

Control Feeding Experiments—*cont.*

Animals.	Number of Feedings and Amount.	Killed or Died. No. of Days.	Post-mortem Examination and Remarks.
1 guinea-pig	10 = 17 cc.	Died 35	**Tubercular.** Well marked ulceration of the small intestine, in its lower third, also of the large intestine and cæcum; mesocolic, mesenteric, and cœliac glands markedly enlarged; liver and spleen, early tubercle; lungs only one or two nodules; mediastinal glands, bronchial glands and glands in the neck and under the jaw all affected. Microscopic examination, tubercle bacilli found.
1 do.	Do.	Died 37	**Tubercular.** Very similar to the above, but lungs normal. Microscopic examination, tubercle bacilli found.
1 do.	Do.	Died 63	**Tubercular.** Very similar to above, but in this case liver apparently unaffected. Microscopic examination, tubercle bacilli found.
3			

TABLE CVIII.—*continued.*

Injection Experiments with Milk to which manifestly Tuberculous Material had been added, Heated at 75° C. (167° F.).

Animals.	Time Heated.	Intraperitoneal Injections.	Killed or Died. No. of Days.	Post-mortem Examination and Remarks.
1 guinea-pig	Heated to **75°**	3, 4 = 6 cc.	Died 24	Too early to show tubercle.
1 do.	Do.	Do.	Died 26	Nil. Abscess in the liver. Microscopic examination showed no tubercle bacilli, but a number of cocci.
1 do.	Do.	Do.	Killed 150	Nil.
3				
1 do.	Heated to **75° C.**	10 = 1 cc.	Died 45	**Tubercular.** A number of nodules in the spleen; one or two patches in the left lobe of the liver; only very early grey points in the lungs; diaphragm mottled with tubercles; deep inguinal, lumbar, and cœliac glands enlarged, hard and yellow. Microscopic examination, tubercle bacilli found.
1 do.	Do.	Do.	Died 45	**Tubercular.** Similar to above in nearly every respect. Microscopic examination, tubercle bacilli found.
1 do.	Do.	Do.	Killed 62	**Tubercular.** Pus at the seat of injection; mesenteric glands enlarged, yellow and hard; a number of distinct tubercle nodules in the spleen and the liver had a number of tubercular patches; no tubercle in the thorax. Microscopic examination, tubercle bacilli found.
3				
1 guinea-pig	7½ minutes	1 = 5 cc.	Killed 40	Nil.
1 do.	Do.	1, 3, 4 = 11 cc.	Died 80	**Tubercular.** Spleen somewhat enlarged and covered with fine tubercle nodules; liver also tubercular; very early points in the lungs. Microscopic examination, tubercle bacilli found.
1 do.	Do.	3, 4 = 6 cc	Killed 98	**Tubercular.** Glands in the groin on both sides and the mesenteric glands enlarged and hard; spleen enormously enlarged; tubercle scattered throughout the substance of the liver; diaphragm and pancreas markedly affected; only early affection of the lungs, but the glands at the root are enormously enlarged and gelatinous; mediastinal, anterior mediastinal, and cœliac glands, and glands in the neck and under the jaw all enlarged and tubercular. Microscopic examination, tubercle bacilli found.
3				

Control Injection Experiments.

Animals.	Injections.	Killed or Died. No. of Days.	Post-mortem Examination and Remarks.
1 guinea-pig	1 = ½ cc.	Died 58	**Tubercular.** There is a subcutaneous abscess at the seat of injection; spleen markedly tubercular; in the liver there are two tubercle nodules; other organs apparently normal. Microscopic examination, tubercle bacilli found.
1 do.	Do.	Died 80	**Tubercular.** Spleen and liver distinctly tubercular; a number of patches in the lungs; bronchial, mediastinal, and mesenteric glands all affected. Microscopic examination, tubercle bacilli found.
2			
1 guinea-pig	3 = 5 cc.	Died 15	Too early to show tuberculosis.
1 do.	Do.	Died 19	**Tubercular.** Peritoneal wall and omentum affected; spleen slightly nodular; glands at hilus of liver enlarged and tubercular; other organs normal. Microscopic examination, tubercle bacilli found.
1 do.	Do.	Died 19	**Tubercular.** Pancreas only slightly nodular. Microscopic examination, tubercle bacilli found.
3			
1 guinea-pig	7 = 1 cc.	Killed 56	**Tubercular.** Spleen enlarged and tubercular; a number of early tubercular patches throughout the substance of the liver; glands in the hilus of the liver enlarged and tubercular; cervical glands and those at the root of the lung indurated, enlarged, and tubercular; early tubercle of the lungs, in which tubercle bacilli were found on microscopical examination.
1 do.	Do.	Died 4	Too early to show tubercle.
1 do.	Do.	Died 18	**Tubercular.** A large abscess had formed at the seat of inoculation; gland in the groin on the same side enlarged and suppurating; gland on the opposite side similarly affected but in a lesser degree; very early tubercle of the spleen and liver. Microscopic examination, tubercle bacilli found.
3			

These also serve as controls for No. 8 material.
Material No. 9 = Feedings tubercular.

TABLE CVIII.—*continued.*

Injection Experiments with Milk to which manifestly Tuberculous Material had been added, Heated at 75° C. (167° F.)—*cont.*

Animals.	Time Heated.	Intraperitoneal Injections.	Killed or Died. No. of Days.	Post-mortem Examination and Remarks.
1 guinea-pig	15 minutes	1 = 5 cc.	Killed 35	Nil.
1 do.	Do.	1, 3, 4 = 11 cc.	Killed 132	Nil.
1 do.	Do.	Do.	Killed 132	**Tubercular.** Glands in the groin on both sides enlarged, as are also mesenteric glands; spleen, liver, and pancreas all extensively tubercular; diaphragm markedly affected; a number of patches in the lungs and the glands at the root are very much enlarged, hard, and gelatinous; mediastinal and anterior mediastinal glands, and the glands in the neck and under the jaw and the cœliac glands all enlarged and tubercular. Microscopic examination showed rod-shaped bacteria and a few cocci, with here and there a single imperfectly stained tubercle bacillus which is apparently undergoing degenerative changes.
3				
1 guinea-pig	22½ minutes	1, 3, 4 = 11 cc.	Killed 132	Nil.
1 do.	Do.	Do.	Killed 132	**Tubercular.** Glands in the groin on both sides slightly enlarged, evidently affected with early tubercle; spleen not much enlarged but nodular; several patches of tubercle in the liver; some gelatinous-looking patches in the lungs; bronchial glands enlarged, hard and gelatinous; the glands in the neck and under the jaw and the mesenteric and cœliac glands affected. Microscopic examination showed numerous rods and cocci stained blue, but degenerated and imperfectly stained tubercle bacilli could be found sparsely scattered throughout cover glass preparation.
1 do.	Do.	3, 4 = 6 cc.	Died 40	Nil.
3				
1 guinea-pig	30 minutes	1, 3, 4 = 11 cc.	Died 87	Nil.
1 do.	Do.	Do.	Died 87	Nil.
1 do.	Do.	Do.	Killed 132	Nil.
3				
1 guinea-pig	45 minutes	4 = 1 cc.	Died 40	Nil.
1 do.	Do.	Do.	Killed 129	Nil.
1 do.	Do	Do.	Killed 129	Nil.
3				

Control Injection Experiments—*cont.*

Animals.	Injections.	Killed or Died. No. of Days.	Post-mortem Examination and Remarks.
1 guinea-pig	10 = 1 cc.	Killed 40	**Tubercular.** Wound still open and indurated and contained a small quantity of pus; inguinal gland enlarged, contained pus; cœliac gland tubercular; liver and spleen both enlarged and studded with patches and nodules of tubercle; glands behind the sternum enlarged, yellow, tubercular, but the lungs are quite free from tubercle. Tubercle bacilli found on microscopic examination of one of the nodules found in the spleen.
1 do.	Do.	Killed 40	**Tubercular.** Very similar to the above. Microscopic examination, tubercle bacilli found.
1 do.	Do.	Died 16	**Tubercular.** Inguinal gland slightly enlarged; some thickening at the seat of inoculation. A small abscess has formed. Microscopic examination, tubercle bacilli found in the discharge.
3			

TABLE CIX

Experiments with Milk to which manifestly Tuberculous Material had been added, exposed to a Temperature of 80° C. (176° F.)

Materials used.

(1.) Caseous tubercular glands from guinea pigs + sound milk.
Control experiments.—**Injection, 2** guinea pigs, **2 tubercular.**

(2.) Tubercular milk from Cow No. 25, + tubercular lung of cow from Metropolitan Cattle Market + sound milk.
Control experiments.—**Feeding, 3** guinea pigs, **2 tubercular,** 1 died too early to show tubercles.

(3.) Tubercular spleen, lung, liver, and glands of pig and guinea pigs + sound milk.
Control experiments.—**Injection, 3** guinea-pigs, **2 tubercular,** 1 died too early to show tubercle.

(4.) Tubercular human lung + sound milk.
Control experiments.—**Feeding, 3** guinea pigs, **1** guinea pig **tubercular,** 1 nil, 1 died too early to show tubercle, **1** cat, **Tubercular.**

(5.) Tubercular udder sent from Birkenhead + sound milk.

(6.) Tubercular human lung + sound milk.
Control experiments.—**Feeding, 3** guinea pigs, **1 tubercular,** 2 died too early to show tubercle.

(7.) Tubercular lung and glands from Cow No. 25, + sound milk.

(8.) Tubercular human lung + sound milk.

(9.) Tubercular lung from cow received from Metropolitan Cattle Market + sound milk.
Control experiments.—**Injection, 3** guinea pigs, **3 tubercular.**

Feeding Experiments with Milk to which manifestly Tubercular Material had been added, Heated at 80° C. (176° F.)

Animals.	Time Heated.	Number of Feedings and Amount.	Killed or Died. No. of Days.	Post-mortem Examination and Remarks.
1 cat	Heated to **80° C.**	7, 8 = 650 cc.	Killed 129	Nil. Pigmentation of mesenteric glands.
1 kitten	Heated to **80° C.**	9 = 300 cc.	Died 7	Too early to show tubercle.
1 guinea pig	Heated to **80° C.**	8 = 80 cc.	Killed 98	Nil. Small round grey nodule in liver. Microscopic examination shows abscess formation with well-marked granulation tissue.
1 do.	Do.	Do.	Killed 98	Nil.
1 do.	Do.	Do.	Killed 98	Nil.
3				
1 guinea pig	5 minutes	2, 4 = 300 cc.	Died 44	Nil.
1 do.	Do.	2, 4. 8 = 350 cc.	Died 108	Nil.
1 do.	Do.	Do.	Killed 173	Nil.
1 do.	Do.	8 = 50 cc.	Died 76	Nil.
4				
1 pig	5 minutes	5, 6, 7, 8 = 1,400 cc.	Killed 117	**Tubercular.** Animal appears to be fairly well nourished. On the left tonsil is a small white scar. salivary and lymphatic glands in submental and parotid regions are caseous on both sides, but especially on the left. Caseo-calcarious masses, the result of tubercular degeneration in the anterior and posterior mediastinal and bronchial glands. Numerous tubercular caseous nodules in the lungs. There are a couple of nodules of tubercle on the upper (pleural) surface of the diaphragm; liver and spleen both distinctly tubercular (caseous nodules); cœliac and mesenteric glands tubercular; numerous caseous tubercular nodules between the layers of the omentum, but there are none on the serous surface. In the large intestine close to the cæcum is a single yellow tubercular nodule which appears to have commenced to grow in a solitary gland. Other organs and glands normal. On microscopic examination, tubercle bacilli were readily demonstrated.

Control Feeding Experiments.

Animals.	Number of Feedings and Amount.	Killed or Died. No. of Days.	Post-mortem Examination and Remarks.
1 guinea pig	2 = 70 cc.	Died 5	Too early to show tubercle.
1 do.	Do.	Killed 119	**Tubercular.** Spleen studded with numerous large tubercular nodules; a number of fine tubercular points in liver; mesenteric glands enormously enlarged and tubercular; extensive ulceration of both large and small intestines; anterior mediastinal, and bronchial glands enlarged and tubercular; a number of minute tubercular granulations in both lungs. Microscopic examination, tubercle bacilli found.
1 do.	Do.	Killed 119	**Tubercular.** Condition very similar to above. Microscopic examination, tubercle bacilli found.
3			
1 guinea pig	4 = 33 cc.	Died	Too early to show tubercle.
1 do.	Do.	Killed 129	**Tubercular.** Spleen enormously enlarged and extensively tubercular. Well-marked yellow tubercular patches in the liver; pancreas also studded with tubercular nodules; mesocolic and cœliac glands tubercular; tubercular ulceration of the intestine; glands in the thorax and lungs only slightly affected. Microscopic examination, tubercle bacilli found.
1 do.	Do.	Killed 12	Nil.
3			
1 cat	4 = 750 cc.	Killed 77	**Tubercular.** Two small tubercular patches in the cortex of one of the mesenteric glands; none in the medulla; all other organs normal. Microscopic examination, tubercle bacilli found.

TABLE CIX.—*continued.*

Feeding Experiments with Milk to which manifestly Tubercular Material had been added, Heated at 80° C. (176° F.)—*cont.*

Animals.	Time Heated.	Number of Feedings and Amount.	Killed or Died. No. of Days.	Post-mortem Examination and Remarks.
1 cat	5 minutes	8 = 200 cc.	Killed 119	Nil.
1 guinea pig	10 minutes	2 = 100 cc.	Died 31	Nil.
1 do.	Do.	Do.	Died 41	Nil.
1 do.	Do.	8 = 50 cc.	Killed 104	Nil.
1 do.	Do.	2, 4, 9 = 450 cc.	Died 111	Nil.
4				
1 pig	10 minutes	5, 6, 7, 8 = 1,400 cc.	Killed 117	**Tubercular.** Animal in fairly good condition. A small scar on each tonsil; lymphatic glands below the jaw and on the neck caseous on both sides. Axillary glands perfectly normal. Caseo-calcareous tubercle of the mediastinal and bronchial glands. Caseous miliary tubercle in the lungs. Spleen and liver both studded with nodules of caseous tubercle, as are also some of the mesenteric glands. Intestines contained four lumbricoid worms, otherwise perfectly normal. Other organs, glands, and serous membranes quite free from tubercle. Microscopic examination, tubercle bacilli demonstrated in the affected parts.

Control Feeding Experiments—*cont.*

Animals.	Number of Feedings and Amount.	Killed or Died. No. of Days.	Post-mortem Examination and Remarks.
1 pig	5, 6, 7, 8 = 1,400 cc.	Killed 117	**Tubercular.** Animal much emaciated: submaxillary or submental glands and glands in the parotid region enormously enlarged, tubercular and purulent. The tonsils are distinctly scarred, and there are one or two yellow points in their substance, whilst the surrounding lymphatic glands in the neck and those in the line extending to the upper margin of the scapula are all tubercular, as are also the anterior and posterior mediastinal, the poststernal, and bronchial glands. The lungs are distinctly tubercular; the spleen is markedly affected; early grey tubercular granulation seen in the liver; mesenteric, mesocolic, and cœliac glands, and glands at the hilus of the liver, and along both curvatures of the stomach, are greatly enlarged and tubercular. There is no ulceration of the intestine which, however, was filled with lumbricoid worms. In this case the infection has evidently spread from the pharynx and tonsils. On microscopic examination, tubercle bacilli were found in considerable numbers.
1 guinea pig	6 = 100 cc.	Died 7	Too early to show tubercle.
1 do.	Do.	Died 7	Do.
1 do.	Do.	Died 33	**Tubercular.** Early tubercle of the mesenteric glands; patches of tubercular ulceration in the large intestine, especially near the cæcum. Other organs normal.
3			

TABLE CIX.—*continued.*

Injection Experiments with Milk to which manifestly Tubercular Material had been added, Heated at 80° C. (176° F.)

Animals.	Time Heated.	Intraperitoneal Injections.	Killed or Died. No. of Days.	Post-mortem Examination and Remarks.
1 guinea pig	Heated to **80° C.**	3 = 5 cc.	Died 20	Too early to show tubercle.
1 do.	Do.	3, 4 = 7 cc.	Died 32	Nil.
1 do.	Do.	Do.	Died 42	Nil.
3				

Control Injection Experiments.

Animals.	Intraperitoneal Injections.	Killed or Died. No. of Days.	Post-mortem Examination and Remarks.
1 guinea pig	1 = ½ cc.	Died 58	**Tubercular.** A subcutaneous abscess at the seat of inoculation; pus from this abscess is cheesy, and contains tubercle bacilli; well-marked tubercle of the spleen; only a couple of nodules in the liver. Microscopic examination, tubercle bacilli found.
1 do.	Do.	Died 89	**Tubercular.** Spleen, liver, and lungs all affected, also mediastinal and mesenteric glands. Microscopic examination, tubercle bacilli found.
2			

TABLE CIX.—*continued.*

Injection Experiments with Milk to which manifestly Tubercular Material had been added, Heated at 80° C. (176° F.)—*cont.*

Animals.	Time Heated.	Intraperitoneal Injections.	Killed or Died, No. of Days.	Post-mortem Examination and Remarks.
1 guinea pig	Heated to **80° C.**	3, 4 = 7 cc.	Died 23	Nil.
1 do.	Do.	Do.	Died 33	Nil.
1 do.	Do.	Do.	Killed 149	Nil.
3				
1 guinea-pig	Heated to **80° C.**	9 = 1 cc.	Died 8	Too early to show tubercle.
1 do.	Do.	Do.	Killed 62	Nil.
1 do.	Do.	Do.	Killed 62	Nil.
3				
1 guinea-pig	**5** minutes	1, 3 = 10 cc.	Killed 53	Nil.
1 do.	Do.	1, 3, 4 = 12 cc.	Died 105	Nil.
1 do.	Do.	3, 4 = 7 cc.	Died 61	Nil.
3				
1 guinea-pig	**10** minutes	1, 3 = 10 cc.	Killed 53	Nil.
1 do.	Do.	1, 3, 4 = 12 cc.	Died 87	Nil.
1 do.	Do.	Do.	Killed 184	Nil.
3				
1 guinea-pig	**15** minutes	1, 3, 4 = 12 cc.	Died 58	Nil.
1 do.	Do.	Do.	Died 58	Nil.
1 do.	Do.	3, 4 = 7 cc.	Died 25	Nil.
3				
1 guinea-pig	**20** minutes	1, 3 = 10 cc.	Died 53	Nil.
1 do.	Do.	1, 3, 4 = 11	Died 73	Nil.
1 do.	Do.	4 = 1 cc.	Killed 118	Nil.
3				

Control Injection Experiments—*cont.*

Animals.	Intraperitoneal Injections.	Killed or Died. No. of Days.	Post-mortem Examination and Remarks.
1 guinea-pig	3 = 1 cc.	Died 15	Too early to show tubercle.
1 do.	Do.	Died 19	**Tubercular.** Peritoneal covering of the wall of the abdomen and omentum, the spleen and a gland in the hilus of the liver all affected. Microscopic examination, tubercle bacilli found.
1 do.	Do.	Died 19	**Tubercular.** Pancreas slightly nodular. Microscopic examination, tubercle bacilli found.
3			
Material 4 = feeding controls tubercular.			—
1 guinea-pig	9 = 1 cc.	Killed 40	**Tubercular.** Wound still open and indurated, and contains pus; deep inguinal gland and cœliac glands enlarged; spleen nodular; and liver mottled with numerous white patches; lungs normal; glands behind sternum enlarged. Microscopic examination, tubercle bacilli found.
1 do.	Do.	Killed 40	**Tubercular.** Very similar condition to above. Microscopic examination, tubercle bacilli found.
1 do.	Do.	Died 16	**Tubercular.** Inguinal gland slightly enlarged; thickening of the abdominal wall at the seat of inoculation, where abscess has formed. Microscopic examination, tubercle bacilli found.
3			

TABLE CX.

Experiments with Milk to which manifestly Tuberculous Material had been added, exposed to a Temperature of 85° C. (185° F.)

Materials used.

(1.) Caseous tubercular glands from guinea pigs + sound milk.
Control experiments.—**Injection, 2** guinea pigs, **2 tubercular.**

(2.) Tubercular spleen, liver, lung, and glands of pig and guinea pigs + sound milk.
Control experiments.—**Injection, 3** guinea pigs, **2 tubercular.** 1 died too early to show tubercle.

(3.) Tubercular human lung + sound milk.
Control experiments.—**Feeding, 3** guinea pigs, **1 tubercular.** 2 died too early to show tubercle.

(4.) Tubercular lung of cow received from Metropolitan Cattle Market + sound milk.
Control experiments.—**Injection, 3** guinea pigs, **3 tubercular.**

(5.) Tubercular milk from Cow No. 25 + tubercular lung of cow + sound milk.
Control experiments.—**Feeding, 3** guinea pigs, **2 tubercular.** 1 died too early to show tubercle.

Feeding Experiments with Milk to which manifestly Tubercular Material had been added, Heated at 85° C. (185° F.)

Animals.	Time Heated.	Number of Feedings and Amount.	Killed or Died. No. of Days.	Post-mortem Examination and Remarks.
1 guinea pig	Heated to **85° C.**	3 = 150 cc.	Died 34	Nil.
1 do.	Do.	Do.	Killed 121	Nil.
1 do.	Do.	Do.	Killed 121	Nil.
3				
1 guinea pig	**2½** minutes	3 = 150 cc.	Died 17	Too early to show tubercle.
1 do.	Do.	Do.	Died 28	Nil.
1 do.	Do.	Do.	Died 35	Nil.
3				
1 guinea pig	**5** minutes	3, 5 = 250 cc.	Died 52	Nil.
1 do.	Do.	3 = 15 cc.	Died 40	Nil.
1 do.	Do.	3, 5 = 250 cc.	Died 70	Nil.
3				
1 guinea pig	**7½** minutes	5 = 200 cc.	Died 44	Nil.
1 do.	Do.	3 = 150 cc.	Killed 20	Nil.
1 do.	Do.	3, 5 = 350 cc.	Killed 171	Nil.
3				

Control Feeding Experiments.

Animals.	Number of Feedings and Amount.	Killed or Died. No. of Days.	Post-mortem Examination and Remarks.
1 guinea pig	3 = 100 cc.	Died 7	Too early to show tubercle.
1 do.	Do.	Died 7	Do.
1 do.	Do.	Died 33	**Tubercular.** Early tubercle of the mesenteric glands. Patches of tubercular ulceration in the large intestine, especially near the cæcum. Other organs normal.
3			
1 guinea pig	5 = 70 cc.	Died 5	Too early to show tubercle.
1 do.	Do.	Killed 119	**Tubercular.** A number of large tubercle nodules in the spleen, and numerous small grey points in the liver. Mesenteric, mesocolic, and cœliac glands enormously enlarged and tubercular. Intestines, both large and small, extensively ulcerated. Poststernal, posterior mediastinal, and bronchial glands all enlarged and tubercular. A few small tubercular points in the lungs. Microscopic examination, tubercle bacilli found.
1 do.	Do.	Killed 119	**Tubercular.** Very similar to above. Microscopic examination, tubercle bacilli found.
3			

TABLE CX.—*continued.*

Injection Experiments with Milk to which manifestly Tubercular Material had been added, Heated at 85° C. (185° F.)

Animals.	Time Heated.	Intraperitoneal Injections.	Killed or Died. No. of Days.	Post-mortem Examination and Remarks.
1 guinea-pig	Heated to **85° C.**	3 = 2 cc.	Died 2	Too early to show tubercle.
1 do.	Do.	Do.	Died 3	Do.
1 do.	Do.	Do.	Died 85	Nil.
3				
1 guinea-pig	Heated to **85° C.**	4 = 1 cc.	Died 44	**Tubercular.** Spleen and liver both enlarged and tubercular, studded with caseous nodules of considerable size; mesenteric glands, glands at the hilus of the liver, and cœliac and mesenteric glands all enlarged, indurated, yellow, and tubercular. Tubercle of the diaphragm and early grey points of tubercle in the lungs, but none in the mediastinal glands. Microscopic examination, tubercle bacilli found.
1 do.	Do.	Do.	Died 52	**Tubercular.** Nodules of tubercle scattered over the whole surface of both spleen and liver; mesenteric and cœliac glands and glands at the hilus of the liver distinctly affected. Many tubercular points on the abdominal wall and in the mesentery. Glands behind the sternum and on the chest wall enlarged and tubercular, but the lungs are only slightly, though distinctly, affected. On microscopic examination, tubercle bacilli are found.
1 do.	Do.	Do.	Killed 62	**Tubercular.** Similar to above, but more advanced. Microscopic examination, tubercle bacilli found.
3				
1 guinea-pig	**2½ minutes**	3 = 2 cc.	Died 1	Too early to show tubercle.
1 do.	Do.	Do.	Died 15	Do.
1 do.	Do.	Do.	Killed 119	Nil.
3				
1 guinea-pig	**5 minutes**	1 = 5 cc.	Died 13	Too early to show tubercle.
1 do.	Do.	1·3 = 7 cc.	Killed 183	Nil.
1 do.	Do.	2·3 = 3 cc.	Killed 149	Nil.
3				

Control Injection Experiments.

Animals.	Injections.	Killed or Died. No. of Days.	Post-mortem Examination and Remarks.
1 guinea-pig	1 = 1½ cc.	Died 58	**Tubercular.** Subcutaneous abscess at the seat of inoculation; in matter from this abscess tubercle bacilli could be demonstrated. The spleen was markedly tubercular. A couple of nodules in the liver. Superficial inguinal and cœliac glands enlarged and tubercular.
1 do.	Do.	Died 80	**Tubercular.** Mesenteric, cœliac, and superficial inguinal glands, spleen and liver all tubercular. Mediastinal and bronchial glands tubercular and a number of tubercular patches in the lungs. Microscopic examination, tubercle bacilli were found.
2			
1 guinea-pig	2 = 1 cc.	Died 15	Too early to show tubercle.
1 do.	Do.	Died 19	**Tubercular.** The peritoneal covering of the wall of the abdomen and the omentum tubercular; as are also the spleen and glands at the hilus of the liver. On microscopic examination tubercle bacilli found.
1 do.	Do.	Died 19	**Tubercular.** Small nodules of tubercle in the pancreas. Microscopic examination, tubercle bacilli found.
3			
1 guinea-pig	4 = 1 cc.	Killed 40	**Tubercular.** Wound still open, edges and floor indurated and purulent; superficial and deep inguinal glands and cœliac glands enlarged; spleen nodular and liver covered with white and yellow tubercular patches; glands behind the sternum enlarged, tubercular; no tubercle elsewhere. Microscopic examination, tubercle bacilli found.
1 do.	Do.	Killed 40	**Tubercular.** Condition very similar to above. Microscopic examination, tubercle bacilli found.
1 do.	Do.	Died 16	**Tubercular.** Superficial inguinal gland slightly enlarged; thickening of the abdominal wall (subcutaneous tissue) at the seat of inoculation. A small abscess had formed at this point. Microscopic examination, tubercle bacilli found.
3			

TABLE CX.—*continued.*

Injection Experiments with Milk to which manifestly Tubercular Material had been added, Heated at 85° C. (185° F.)

Animals.	Time Heated.	Intraperitoneal Injections.	Killed or Died. No. of Days.	Post-mortem Examination and Remarks.
1 guinea-pig	**7½** minutes	1, 3 = 7 cc.	Died 73	Nil.
1 do.	Do.	3 = 2 cc.	Killed 88	Nil.
1 do.	Do.	2, 3 = 3 cc.	Died 20	Too early to show tubercle.
1 do.	Do.	Do.	Killed 150	Nil.
4				
1 guinea-pig	**10** minutes	1 = 5 cc.	Died 61	Nil.
1 do.	Do.	Do.	Died 61	Nil.
1 do.	Do.	3 = 2 cc.	Died 109	Nil.
1 do.	Do.	1, 3 = 7 cc.	Died 68	Nil.
4				

Control Injection Experiments—*cont.*

Animals.	Injections.	Killed or Died. No. of Days.	Post-mortem Examination and Remarks.

TABLE CXI.

Experiments with Milk to which manifestly Tubercular Material had been added, exposed to a Temperature of 90° C. (194° F.)

Materials used.

(1.) Tubercular glands from guinea pigs used for injection experiments only.
Control experiments.—**Injection, 2** guinea pigs, **2 tubercular.**

(2.) Tubercular milk from Cow No. 25 + tubercular lung of cow sent from Metropolitan Cattle Market + sound milk used for feeding experiments only.
Control experiments.—**Feeding, 3** guinea pigs, **2 tubercular,** 1 died too early to show tubercle.

(3.) Tubercular milk from Cow No. 25 + sound milk.
Control experiments.—**Injection, 3** guinea pigs, **3 tubercular.**

(4.) Tubercular spleen, liver, lung, and glands of a pig and guinea pig + sound milk.

Feeding Experiments with Milk to which manifestly Tuberculous Material had been added, Heated at 90° C. (194° F.)

No. of Animals.	Time Heated.	Number of Feedings and Amount.	Killed or Died. No. of Days.	Post-mortem Examination and Remarks.
1 guinea-pig	Heated to **90° C.**	2, 3, 4 = 450 cc.	Died 53	Nil.
1 do.	Do.	Do.	Died 54	Nil.
1 do.	Do.	Do.	Killed 171	Nil.
3				

Control Feeding Experiments.

No. of Animals.	Number of Feedings and Amount.	Killed or Died. No. of Days.	Post-mortem Examination and Remarks.
1 guinea-pig	2 = 70 cc.	Died 5	Too early to show tubercle.
1 do.	Do.	Killed 119	**Tubercular.** Intestines extensively ulcerated; mesenteric glands enormously enlarged; early tubercle of the spleen and liver; mediastinal, poststernal and bronchial glands considerably enlarged; a number of minute tubercle nodules in the lung. Microscopic examination, tubercle bacilli found.
1 do.	Do	Killed 119	**Tubercular.** Condition very similar to above Microscopic examination, tubercle bacilli found.
3			

TABLE CXI.—*continued.*

Injection Experiments with Milk to which manifestly Tuberculous Material had been added, Heated to 90° C. 194° F.

Control Injection Experiments.

No. of Animals.	Time Heated.	Intraperitoneal Injections.	Killed or Died. No. of Days.	Post-mortem Examination and Remarks.	No. of Animals.	Intraperitoneal Injections.	Killed or Died. No. of Days.	Post-mortem Examination and Remarks.
1 guinea-pig	Heated to **90° C.**	1 = 5 cc.	Killed 34	**Tubercular.** Large, hard tubercle nodule in the spleen. Firm white patches in the liver which might be mistaken for remains of an abscess or, at parts, for fatty degeneration of the organ.	1 guinea-pig	1 = ⅕ cc.	Died 58	**Tubercular.** Subcutaneous tubercular abscess at the seat of inoculation; spleen markedly tubercular and enlarged; liver contained a couple of tubercular nodules. Microscopic examination, tubercle bacilli found.
1 do.	Do.	Do.	Died 35	**Tubercular.** Well marked grey tubercle in the walls of the abdomen and in the omentum, which is much contracted; mesenteric, deep inguinal and cœliac glands greatly enlarged; well marked tubercle of spleen, which is four times its normal size; one or two tubercular nodules in the pancreas and numerous grey tubercular points in the liver; beads of tubercle in the lymphatics of the diaphragm; bronchial and mesenteric glands studded with early gelatinous looking tubercle; small grey nodules in the lungs. Microscopic examination, tubercle bacilli found.	1 do. 2	Do.	Died 80	**Tubercular.** Mesenteric glands, spleen, liver, and lungs all distinctly tubercular. Microscopic examination, tubercle bacilli found.
1 do. 3	Do.	3 = 1 cc.	Killed 156	**Tubercular.** Spleen, one large grey nodule apparently tubercular; three large white patches almost like cicatricial tissue, but evidently tubercular, in the liver; a bluish tubercular point with light yellow or greyish centre in one lung.	1 guinea-pig	3 = 5 cc.	Died 22	**Tubercular.** Early tubercle of the liver, spleen, and pancreas; cervical glands enlarged and tubercular. Microscopic examination, tubercle bacilli very numerous.
					1 do.	Do.	Died 28	**Tubercular.** Spleen, liver and pancreas all extensively tubercular; early tubercle of the lung. Microscopic examination, tubercle bacilli numerous.
					1 do. 3	Do.	Died 25	**Tubercular.** Tubercle on the wall of the abdomen and in the omentum; spleen much enlarged and tubercular; well marked tubercle in the liver and pancreas; lungs and poststernal glands distinctly affected. Microscopic examination showed very many tubercle bacilli.

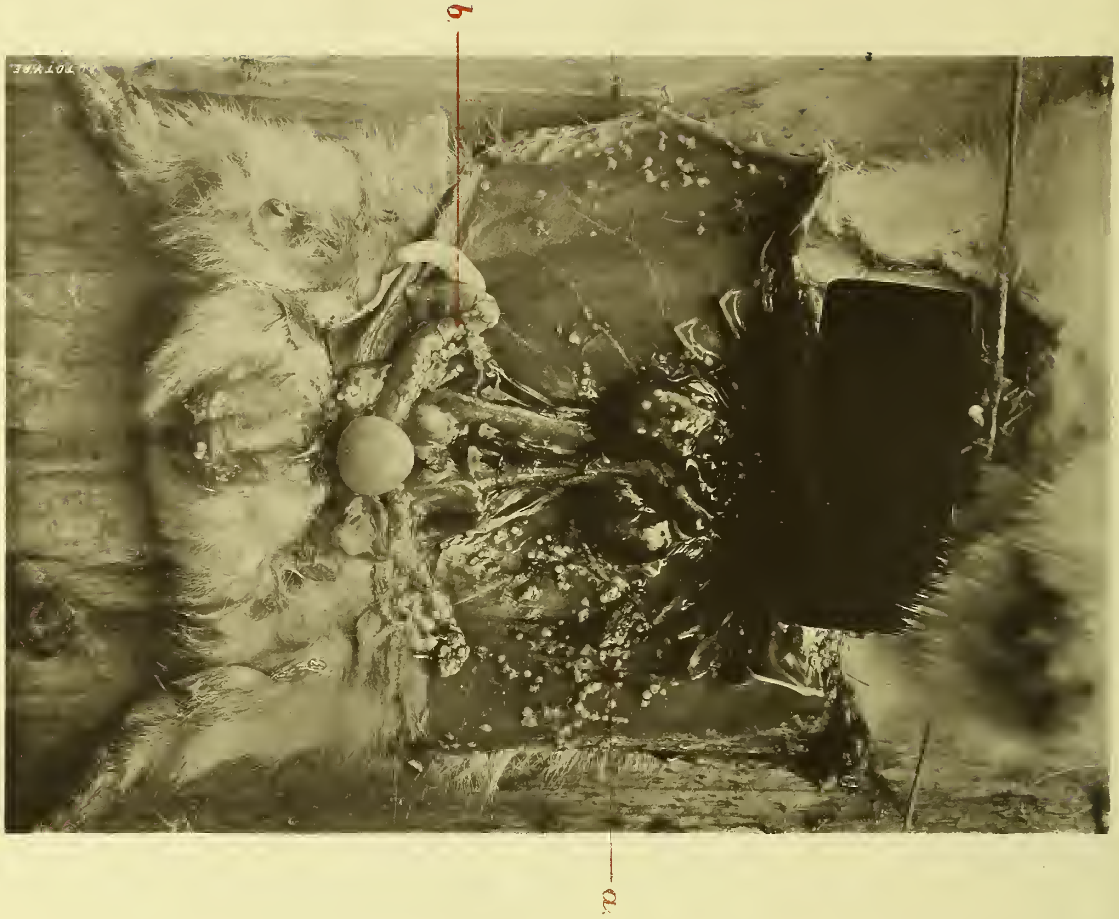


FIG. I.

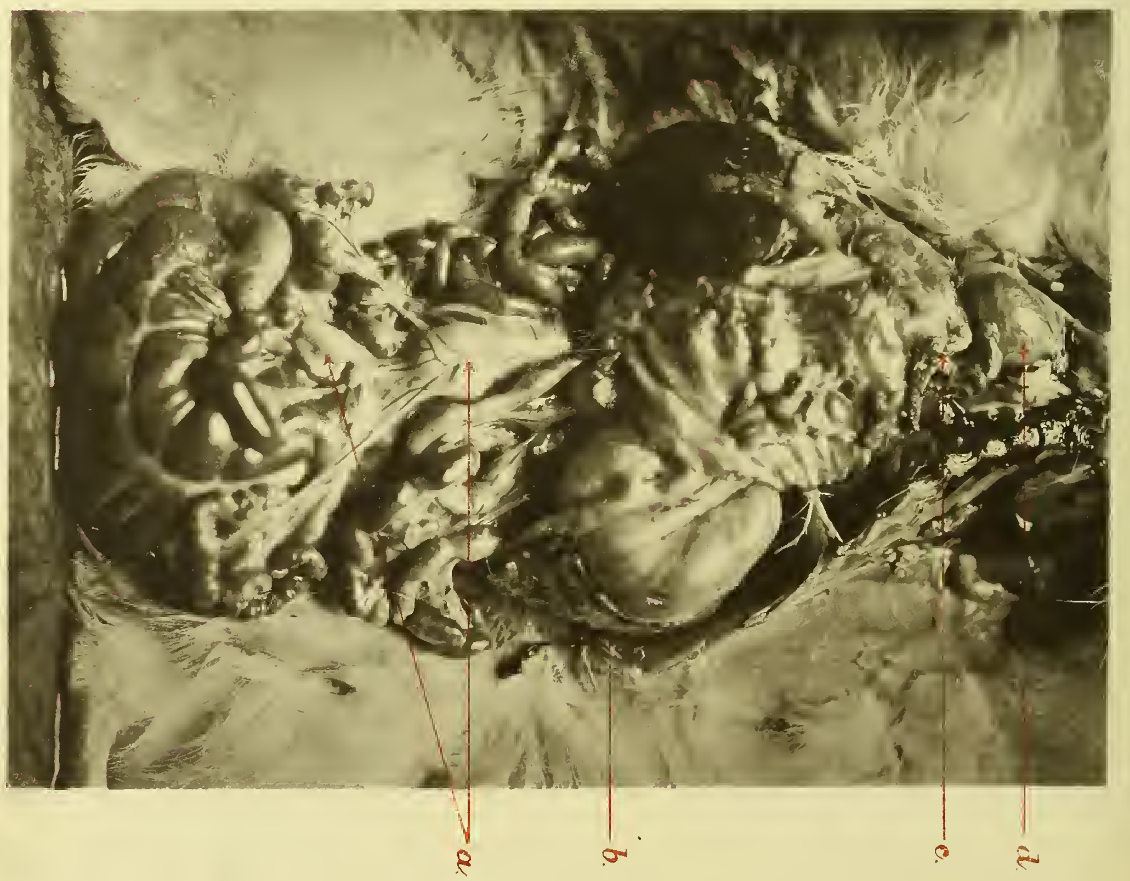


FIG. 2.

PLATE I.

Fig. 1.

Photograph of the abdominal peritoneum of guinea-pig injected intraperitoneally with $2\frac{1}{2}$ cc. of material No. 1A. (Part XIII., Table CV., p. 247). Animal died in 39 days. The extensive distribution of tubercle in the serous membrane is well seen.

The following are the notes of the post-mortem appearances:—

Tubercular. Early tubercle of the spleen. An abscess about the size of a pea had formed in the liver, causing adhesion between that organ and the diaphragm; pancreas enormously enlarged and tubercular; beautiful tubercles (*a*) over the surface of the abdominal wall, and over the serous surface of the intestines; diaphragm studded with radiating tubercle running along the course of the lymphatic vessels; a number of tubercular points in the lungs; cervical glands enormously enlarged and cheesy.

The most marked feature in this case was the general distribution of the tubercle along the lines of the lymphatic vessels of the serous membrane (*b*) on the surface of the various organs, and in the diaphragm, in this latter the radiating distribution of the tubercle was most marked. The lymphatic glands in the abdomen were affected, though in very varying degrees. Tubercle bacilli were found in several of the lesions.

Fig. 2.

Guinea-pig fed with tubercular milk from Danish Cow No. 21 (Part XII., Table C., p. 224) heated to 70° C. for 15 minutes. The animal was killed 93 days afterwards.

The following appearances were observed:—The spleen, (*b*) which will be seen to the right of the cardiac end of the stomach, was very much enlarged; its surface was studded with light grey tubercular patches. A few similar tubercule nodules were seen in the liver, and the mesenteric and mesocolic glands (*a*) were enlarged and caseous. There was no trace of any tubercle in the intestine itself. A number of large tubercular nodules (*c*) were seen in the lung, and the mediastinal (*d*) and bronchial glands were enlarged and caseous. Tubercle bacilli were found in several of the lesions.

PLATE II.

Fig. 3.

Guinea-pig injected with 1 cc. of raw tubercular milk taken from the left anterior teat of the udder of Cow No. 21 (Part XII., Table C., p. 225). The animal died in 53 days, when well-marked tubercle of the spleen (*b*) was found. There was also tubercle of the liver (*c*) and of the under surface of the diaphragm (*d*), the lines of tubercles being arranged radially and were most marked immediately behind the xiphisternum. The glands behind the manubrium sterni and along the left side of the sternum (*e*) were also tubercular, as were also the lungs and the glands at their roots. A number of the mesenteric and mesocolic glands (*a*), the cœliac, and the retro-peritoneal glands generally were in various stages of disease. On microscopic examination tubercle bacilli were found.

Fig. 4.

Guinea-pig injected with raw tubercular milk from Cow No. 20 (Part XII., Table XCIX., p. 223). It died 20 days after the injection.

There was tubercle at the seat of inoculation (*c*), very well seen from the peritoneal surface. Radiating from this point in the left flank was a regular crop of minute tubercles extending to the region around the kidney and from the mesocolon over the lumbar muscles. The omentum was contracted and contained a large number of young tubercles. The mass of glands in the lesser peritoneal sac was completely caseous and the mesenteric glands enormously enlarged. The liver (*a*) was in an advanced condition of tuberculosis, and in it were a number of large bile-stained nodules, and scattered over its surface numerous minute grey points. The under-surface of the diaphragm was studded with beautiful miliary tubercle. The spleen (*b*), which has been tacked on the opposite side of the body in order to bring it from behind the stomach, contained a number of tubercle nodules. The glands in the falciform ligament and immediately behind the sternum (*d*) were tubercular, as were also the glands behind the manubrium sterni, between the clavicle and the first rib, and between the third and fourth ribs on either side. In the diaphragm tubercle was seen to be radiating from the central tendon, towards the margins immediately beneath the peritoneal and pleural surfaces. The lungs were somewhat collapsed at points and were studded with well-developed catarrhal pneumonic patches, probably tubercular; tubercle bacilli were found on microscopical examination.

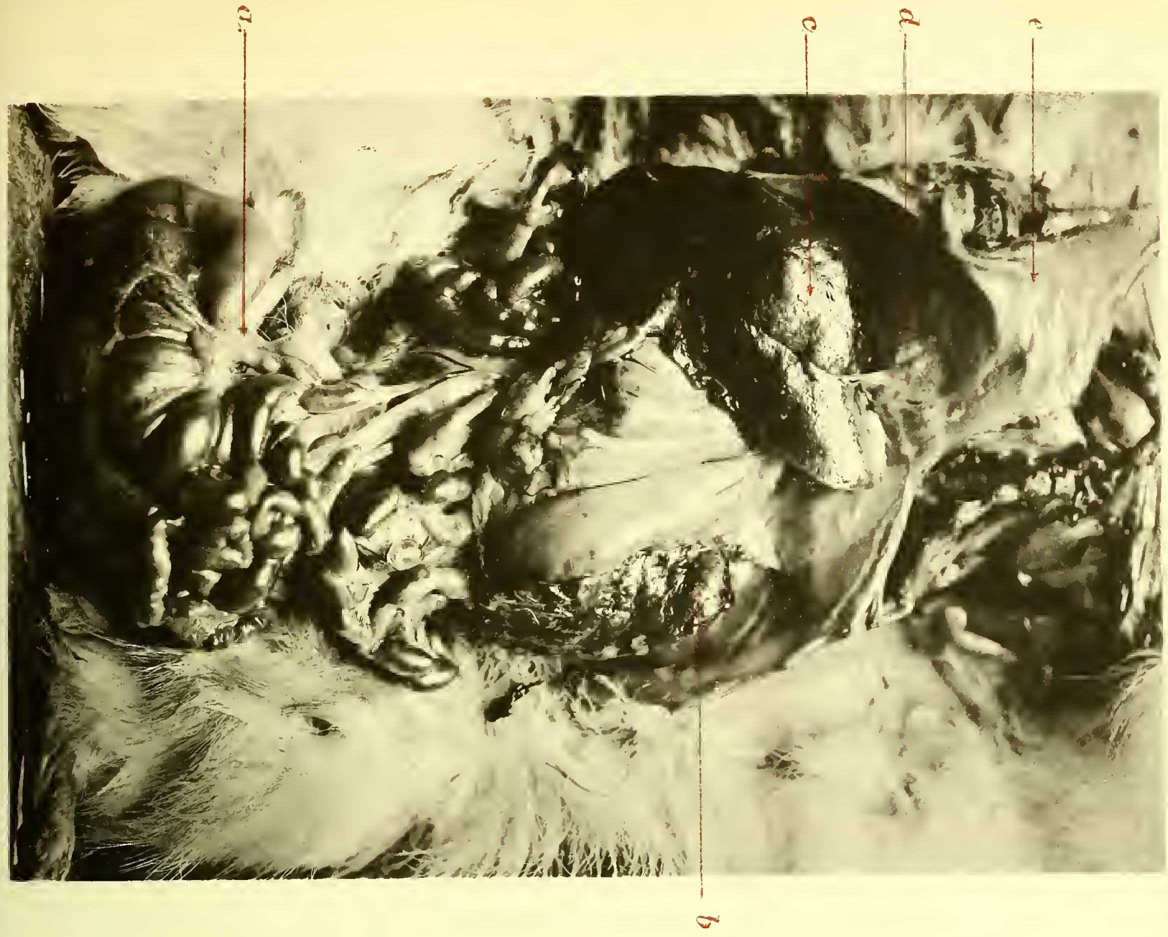


FIG. 3.

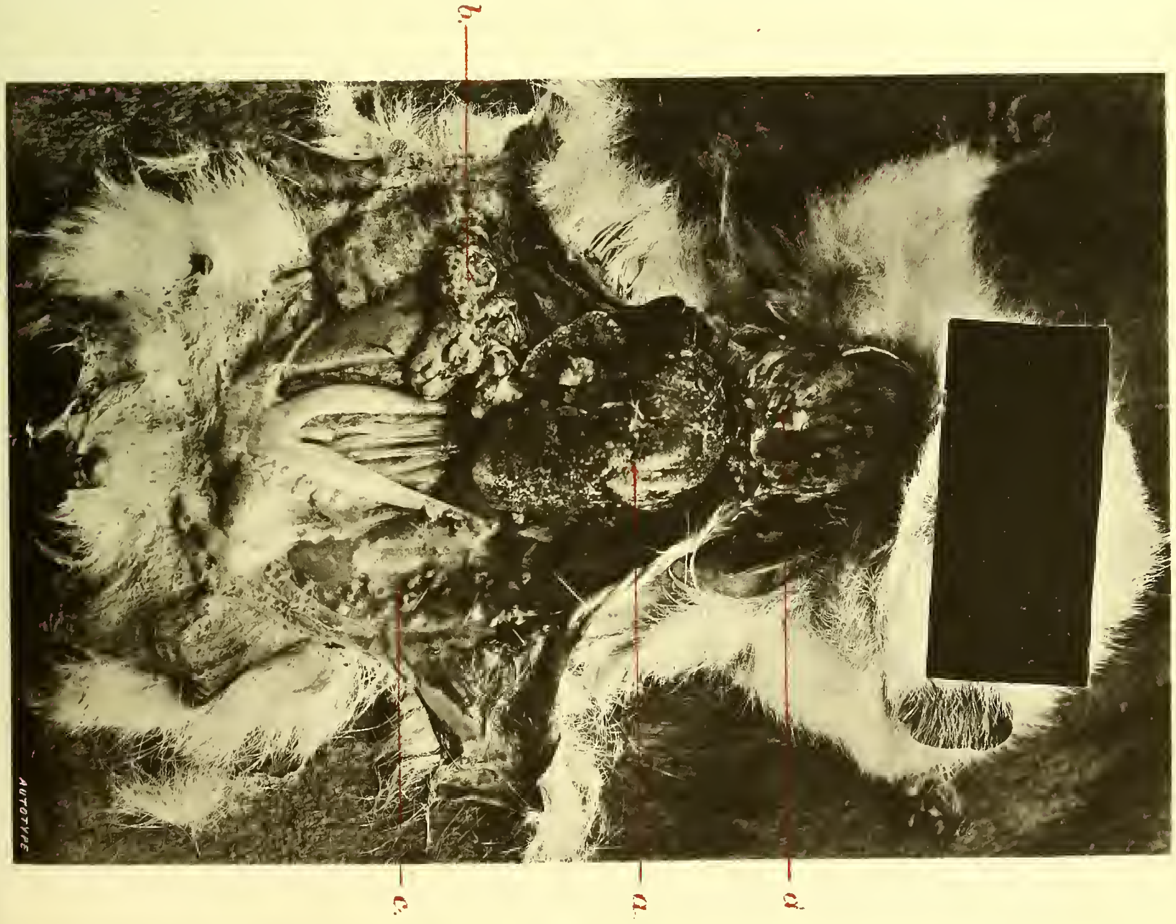


FIG. 4.

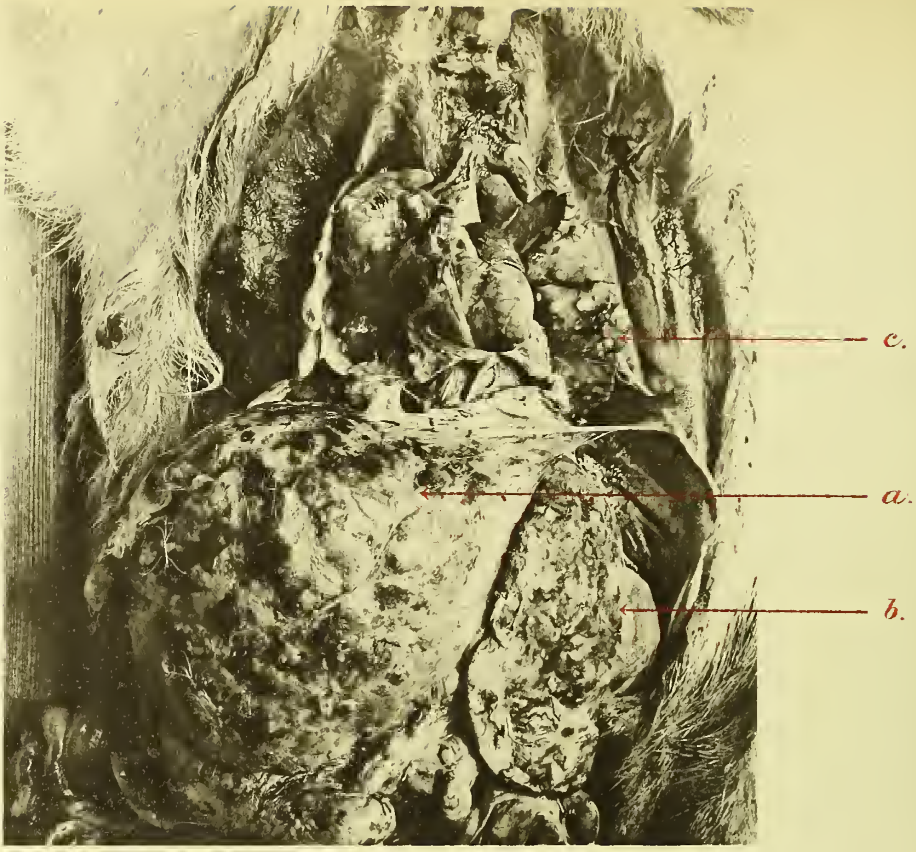


FIG.5.

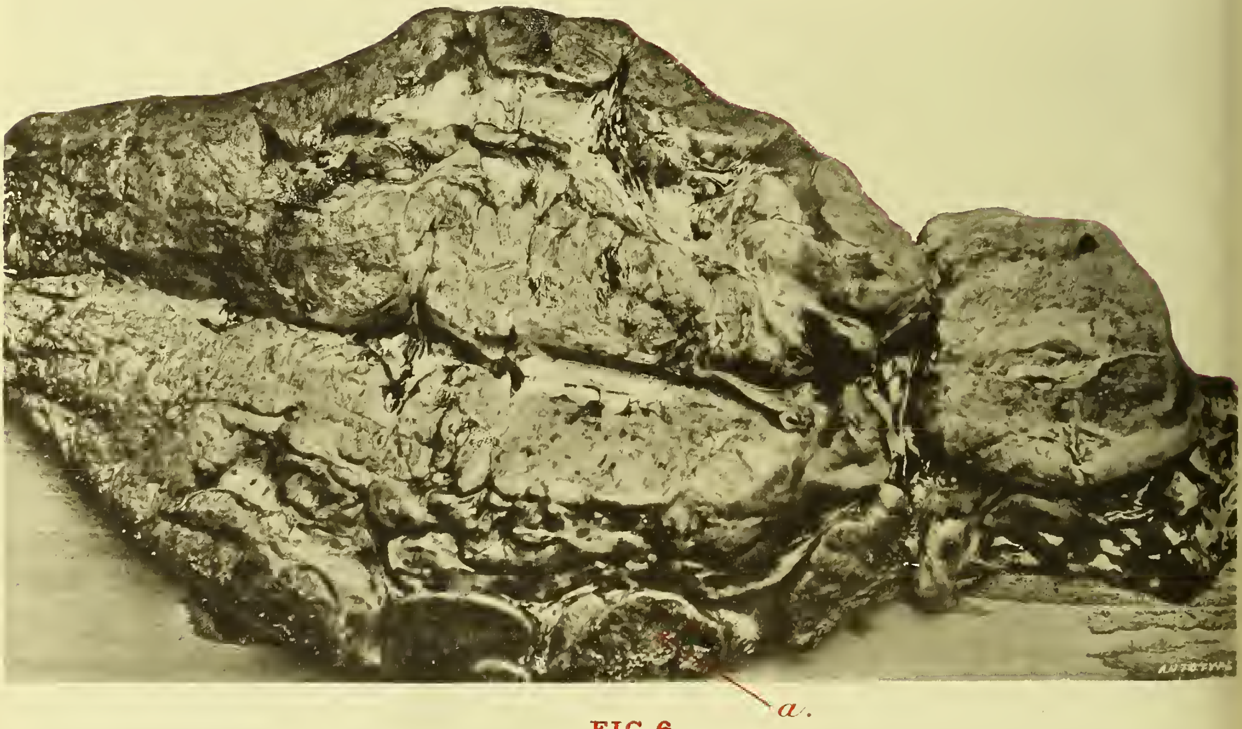


FIG.6.

PLATE III.

Fig. 5.

Guinea-pig injected with 1 cc. of raw tubercular milk from Cow No. 24 (Part XII., Table CII., p.227) and killed 98 days after the injection. In this animal the spleen (*b*), liver (*a*), and pancreas were enormously enlarged and distinctly tubercular. The retroperitoneal glands, in fact all those within the folds of the peritoneum, were also affected. The lungs (*c*) and bronchial glands, the anterior and posterior mediastinal glands, and the glands in the neck were all enlarged and tubercular.

Fig.

A large mass of mediastinal glands from Cow No. 33 (Part X., Table XCV., p. 206).

The glands were in an advanced condition of tuberculosis. Scattered throughout were numerous caseous nodules, especially well seen in the cortex, whilst here and there were small calcareous points, as seen in the figure at *a*. The photograph represents the mass as half the natural size.

PLATE IV.

Fig. 7.

In this specimen we have the tongue, tonsils, &c. of a pig to which 3,000 cc. of the milk from Cow No. 21 (Part XII., Table C., p. 224) had been given in three feedings. The animal was killed at the end of 116 days, when it was found that the tonsils (*b*) were considerably enlarged and irregular on the surface owing to very marked tubercular ulceration; whilst on cutting into them several purulent abscesses were found. The surrounding glands and those situated near the anterior portion of the jaw and running down the neck, forming a continuous chain, were enormously enlarged and tubercular. There were also small tubercular nodules in the mucous membrane of the uvula and of the inferior nasal fossæ. The mediastinal and bronchial glands were also greatly enlarged, and the lungs were tubercular throughout, but especially near their bases, where there were tubercular masses of considerable size. On the under surface of the diaphragm were numerous tubercle nodules.

Fig. 8.

Fig. 8 represents fairly well the appearance of the spleen from this same case.

In this organ were large well-formed tubercular masses from the size of a pea to that of a filbert; these projected considerably from the surface of the spleen, and many of them were caseous. There were small caseating tubercular points scattered over the surface of the liver, and small tubercular nodules in both kidneys, although the mesentric and cœliac glands were distinctly enlarged and tubercular, the intestines were normal. Tubercle bacilli were found both in the tonsils and in the spleen.

These figures are considerably reduced from the natural size.

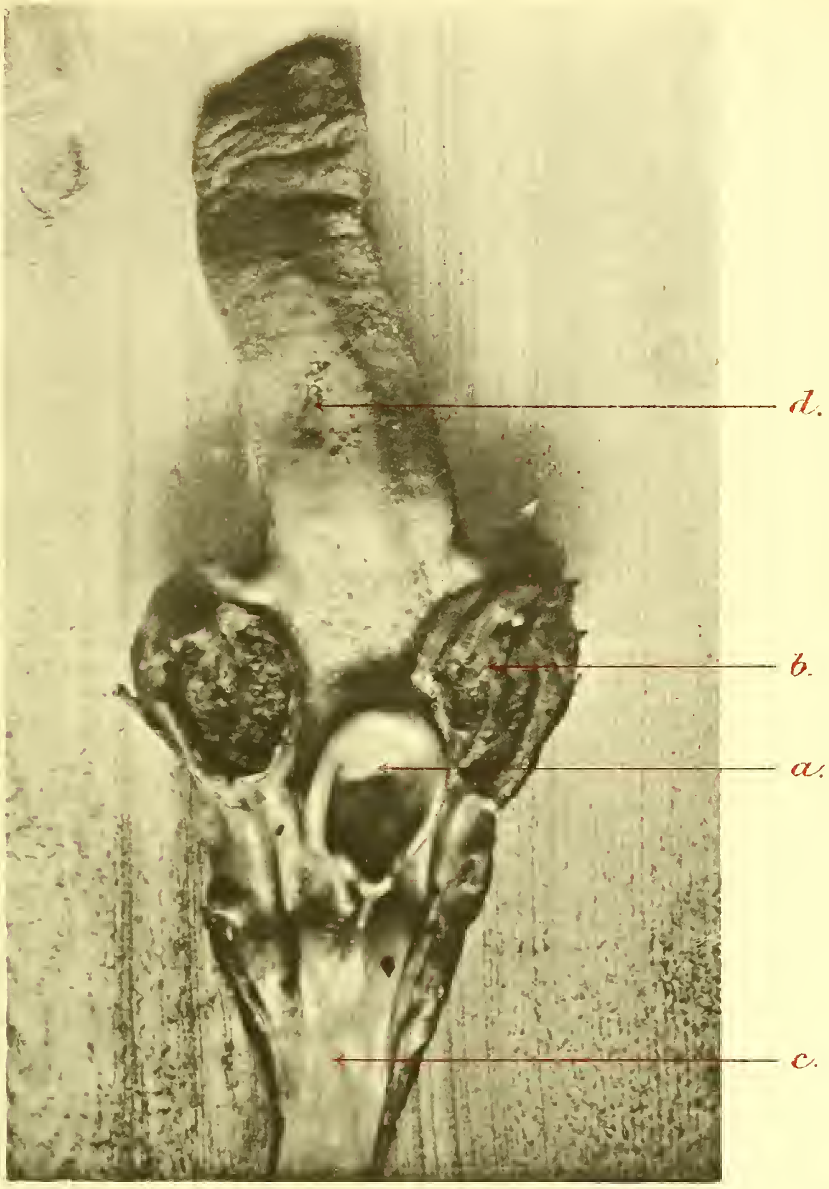


FIG. 7.

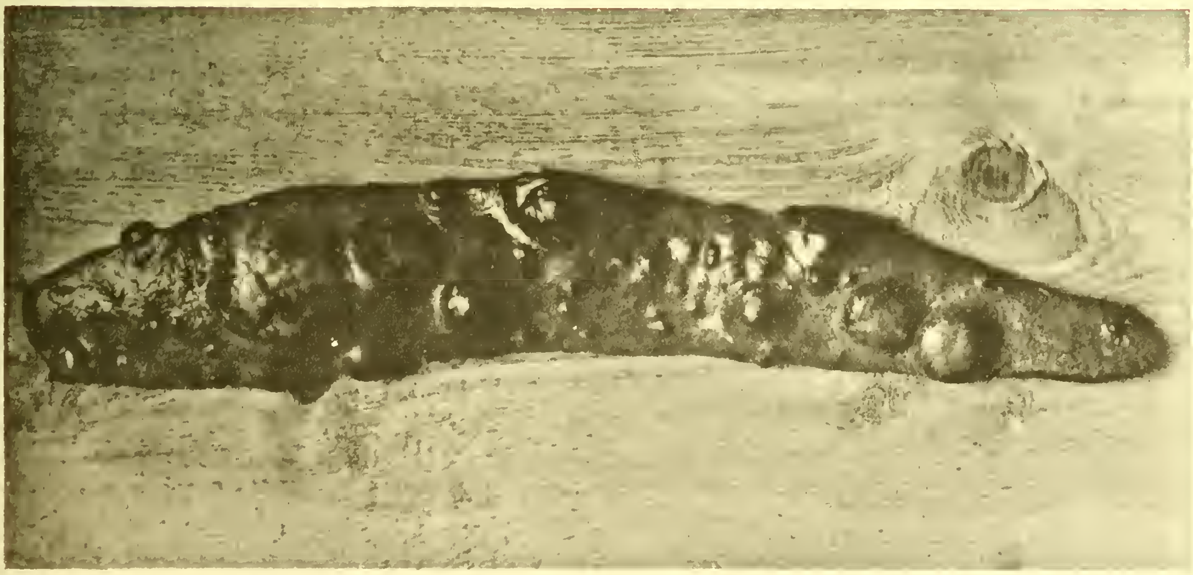


FIG. 8.

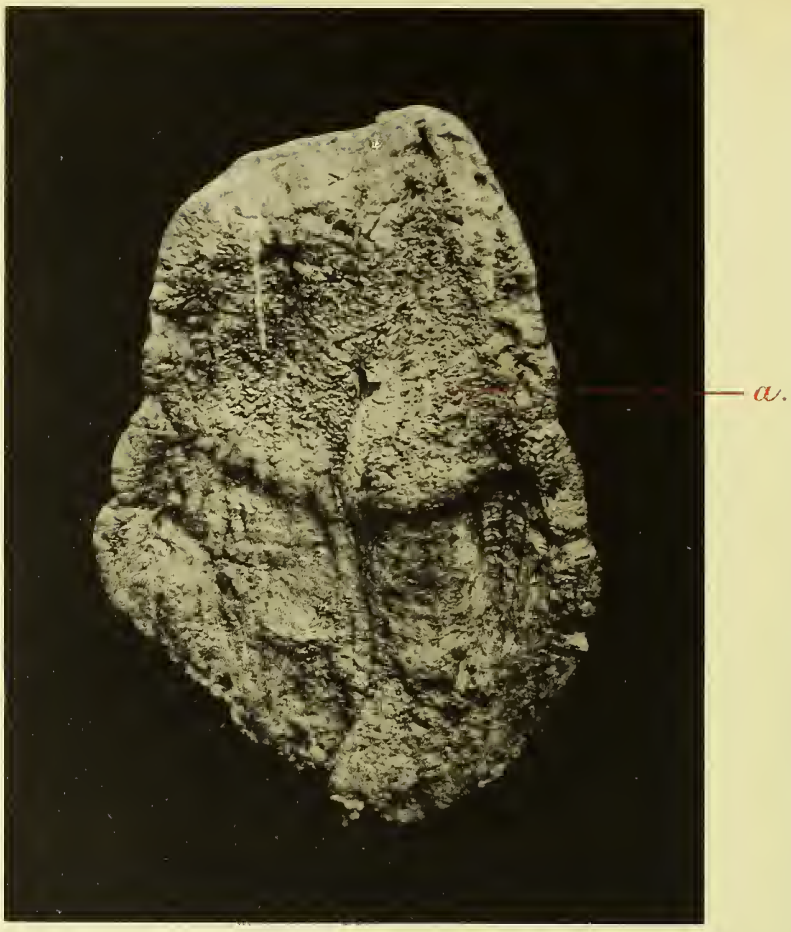


FIG. 9.

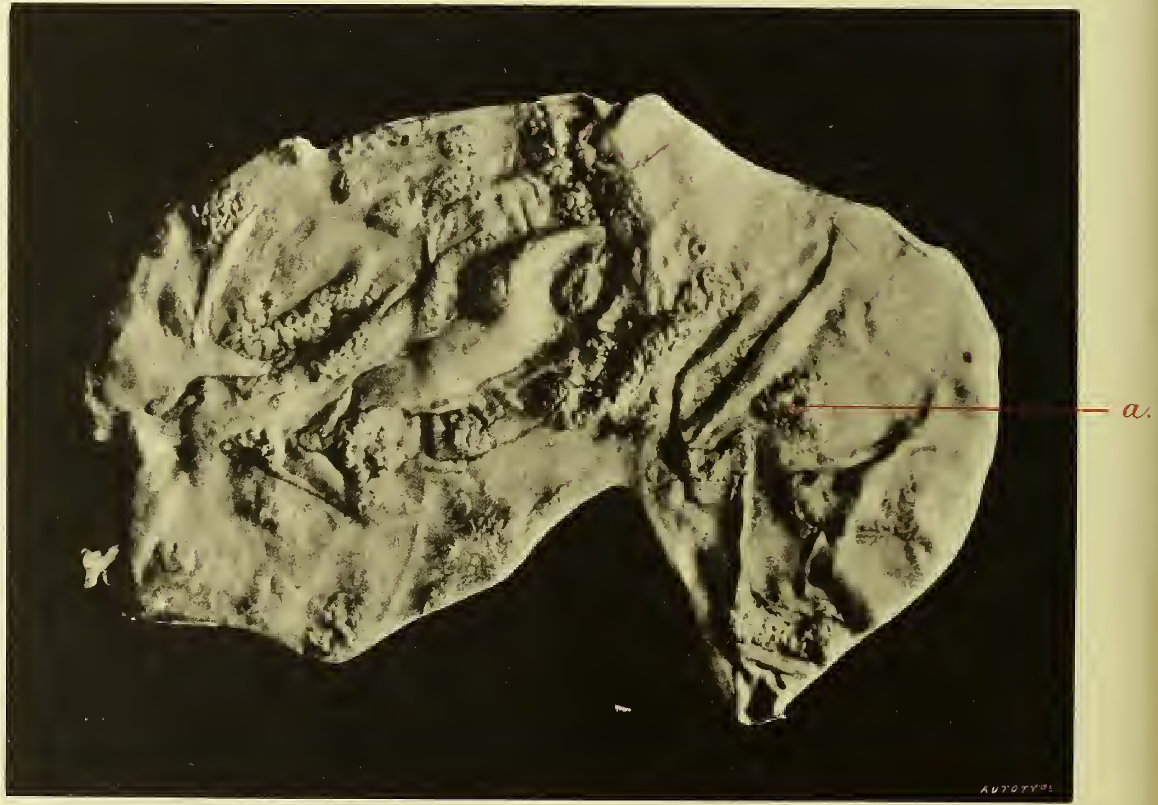


FIG. 10.

PLATE V.

Fig. 9.

Photograph of a section of the tubercular udder of Cow No. 21 (Part X., Table LXXXVII., p. 197). The posterior quarters are placed above in the photograph.

In some parts of the section there was absolutely no normal structure left; there was nothing left but a series of caseous patches and nodules (*a*), which in some cases were soft and purulent. Scattered throughout the remainder of the section were yellow caseous points which are only imperfectly indicated in the photograph, but careful examination will enable the observer to make out projecting caseous points, sometimes single, sometimes in little groups, the surface presenting a very different appearance from that of a normal udder.

A cast of this udder was also prepared.

Fig. 10.

A photograph of the inner wall of the stomach of a pig that had been fed with 1,400 cc. of artificial tubercular milk, Nos. 8, 9, 11, and 14 (Part XIII., Table CVII., p. 264), heated at 70° C. for 30 minutes.

In the description of the post-mortem examination the condition of the stomach is not referred to, as the stomach was immediately taken off to be photographed, so that the notes were not entered in the regular protocol book. On the inner surface of the stomach wall were numerous warty-looking patches and ridges, some of them a couple of inches long and half an inch broad, whilst others were about three-quarters of an inch in diameter. These were at once seen to resemble the patches of bacterial necrosis that had been described in other specimens, and it was decided to obtain a photograph of them and also to examine them microscopically (for microscopic appearances *see* fig. 47, Plate XX.). These patches were paler than the rest of the mucous membrane, the surface was extremely irregular, as already noted, and at some points there was marked ulceration (*a*); the tissue was somewhat hard and friable, breaking down readily under the finger-nail or on slight pressure. No tubercular structure or tubercle bacilli could be made out in any of the organs, but the tonsil and adjacent pharynx were studded with small ulcers in the floor of which were yellow points. The surrounding glands in the neck and under the jaw showed no trace of tubercle. In the intestine, near the cæcum, was an ulcerating patch, in the floor of which were a few yellow points. There were also greyish points in some of Peyer's patches in the small intestine, which, however, were not tubercular. In the cæcum itself was a hard ulcerated patch which under the microscope was found to be in a condition of bacterial necrosis. The mesenteric glands were slightly enlarged but not tubercular; and the spleen, liver and lungs were all normal.

PLATE VI.

Fig. 11.

Cæcum, large intestine and Peyer's patches from a guinea-pig fed with 300 grammes of raw tuberculous lung from Cow No. 16 (Part X. Table LXXXIV., p. 193), given at two feedings. The guinea-pig was killed 35 days after the first feeding, when the two glands in the small intestine were found to be slightly enlarged and opaque. There were similar small opaque patches with slightly congested areas around them, in the cæcum. The liver and the spleen from the same case were both distinctly tubercular; in the lungs there were several gelatinous-looking patches, in which, however, no bacilli could be found. The microscopic examination and the presence of bacilli gave abundant evidence as to the tubercular nature of the other lesions.

Fig. 12.

Glands of the small intestine of a guinea-pig affected with tubercle. The patches were opaque, some considerably raised and yellow with a surrounding area of congestion. There were also several minute tubercular points along the course of the intestine between the larger masses. This animal had been fed with artificial tubercular milk (Part XIII., Table CIII., p. 230), heated at 50° C. for one hour. It died at the end of 123 days, when it was found that the mesocolic, cæcal, mesenteric and cœliac glands were enlarged and caseous. The spleen contained a few tubercle nodules. In the liver the tubercle was more advanced. There was ulceration of both large and small intestine, and the tubercular process had extended directly through the posterior part of the diaphragm to the lungs. The mediastinal and bronchial glands were also affected. On microscopical examination tubercle bacilli were found in considerable numbers.

Fig. 13.

Cæcum and small parts of intestine from a guinea-pig once fed with raw grapes from the ribs of Cow No. 31 (Part X., Table XCIII., p. 204). The guinea-pig died 44 days after this feeding. In the small intestine were one or two opaque points, not yet caseating, situated near the ileo-cæcal valve; in each one there appeared to be a small depression in the centre, but there was no distinct ulceration. In the cæcum were rounded projecting tubercular nodules, most of them commencing to ulcerate and in some there was a very marked crateriform depression. The mesocolic gland seen to the right of the photograph, and the mesenteric glands were enlarged and contained a softened caseo-purulent material. There was early tubercle of the pancreas, spleen and lungs, but the liver appeared to be quite normal. Tubercle bacilli were found on microscopical examination.

Fig. 14.

A small patch of the lower part of the small intestine of Cow No. 33 (Part X., Table XCV., p. 206), somewhat reduced in size in the photograph. In this glandular patch were numerous opaque yellow points evidently tubercular and undergoing caseation. The mucous membrance on the surface had at one or two points given way, but this was not at all a marked feature, though here and there were small central ulcerated depressions above the enlarged tubercular glands. The surrounding mucous membrane was pinker than normal and a number of congested vessels might be seen running transversely towards the opaque patches.

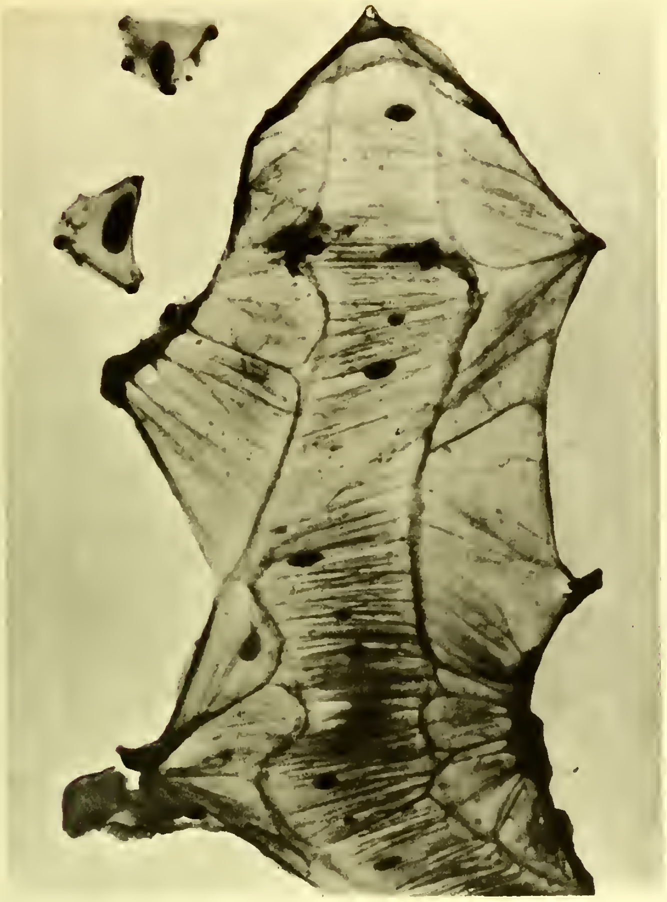


FIG. 11.

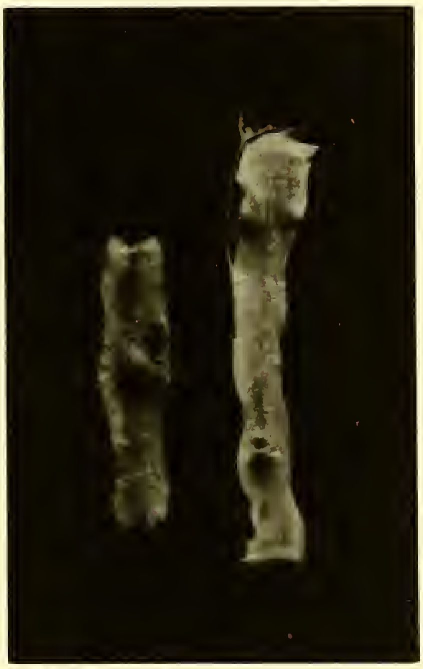


FIG. 12.

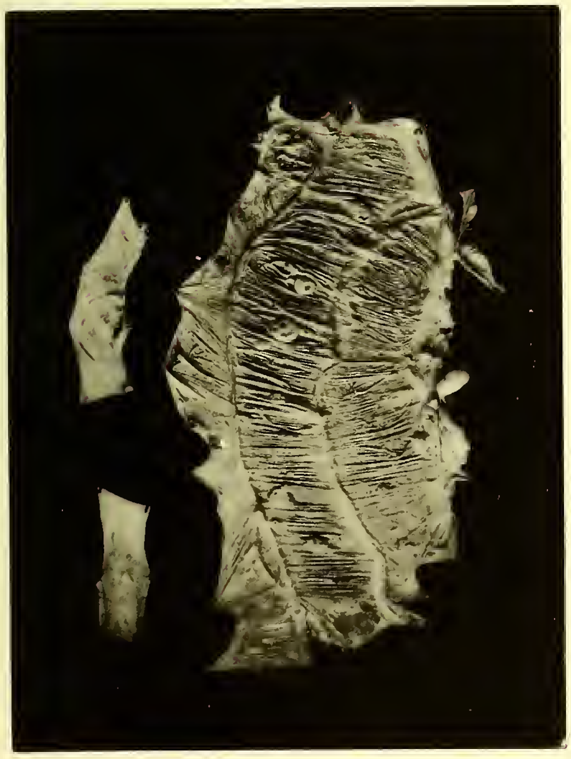


FIG. 13.

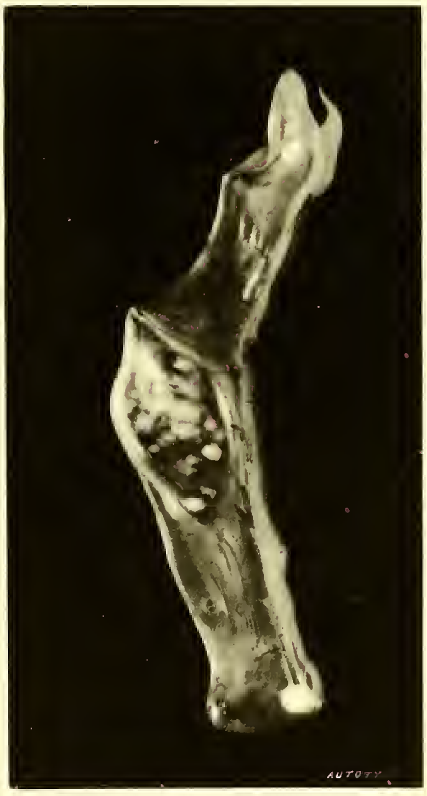


FIG. 14.

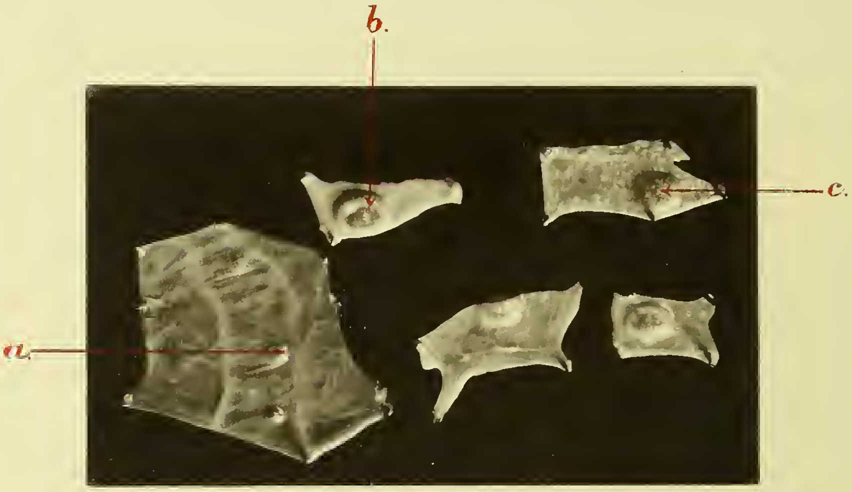


FIG. 15.

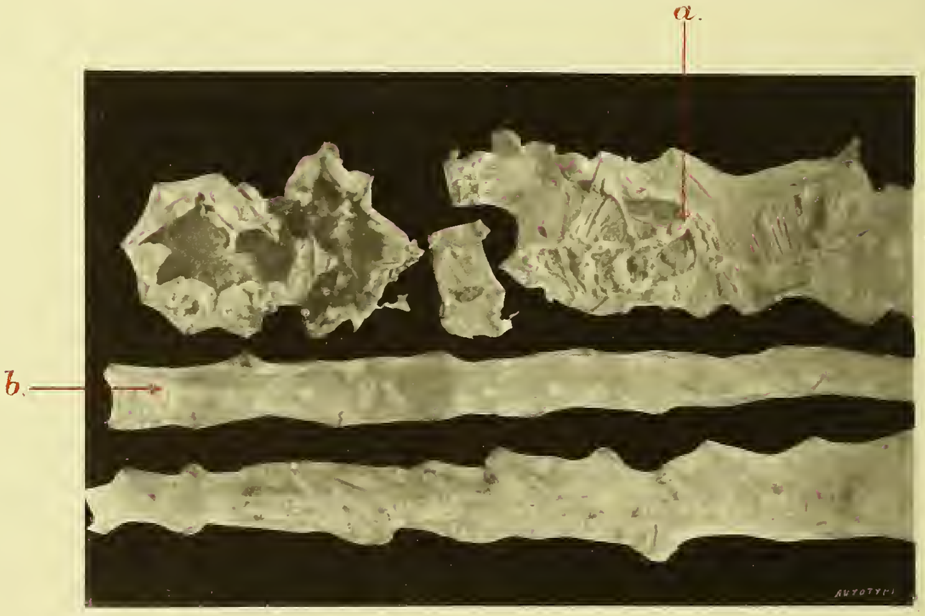


FIG. 16.

PLATE VII.

Fig. 15.

Photograph taken from scraps of the large and small intestines of a guinea-pig fed with roast beef taken from Cow No. 15 (Part X., Table LXXXIII., p. 190). This guinea-pig died two days after the feeding, and it appeared at first sight that we had to deal with a case of tuberculosis of the intestines, accidentally acquired. It was found, however, that this was really a case of pseudo-tuberculosis, as on the most careful examination no tubercle bacilli could be found, though numerous micrococci were present in the lesion. There was venous congestion of the large instestine and of the cæcum. The solitary glands and the Peyer's patches in the small intestine were enlarged and œdematous (*c*), and there were small hæmorrhages into their substance. There were similar enlarged masses, though not so prominent, in the cæcum (*a*). In addition to the larger masses there were a number of minute white opaque points in the position of the solitary glands. In one or two instances the enlarged masses in the Peyer's patches were depressed in the centre, and there was slight ulceration (*b*) of the surface. The mesenteric glands were enlarged and pale. The liver was mottled with small yellow patches distributed very irregularly over its surface. The spleen was normal. There were a couple of yellowish grey points in the lungs, and the mediastinal glands were enlarged and opaque. The patches and the degenerated material were much whiter than tubercular nodules in any stage of development and the breaking down was more complete, so that on examination microscopically one could not make out even the outlines of any cells; and no tubercle bacilli could be found in any one of the lesions, the place of these organisms being taken, as above stated, by micrococci. This condition is especially important from the fact that, until it was examined microscopically, it was taken to be an atypical tubercular lesion. Without microscopical examination it may readily be mistaken for tuberculosis.

Fig. 16.

Cæcum and large and small intestines of a guinea-pig fed with 33 cc. of Material No. 5, "artificial "tubercular milk" (Part XIII., Table CIII., p. 23). This animal, killed 61 days after the feeding, was found to have large tubercular caseous nodules in the spleen. The liver and the mesenteric glands were distinctly tubercular, whilst in the large (*a*) and small (*b*) intestines, as seen in the photograph, there was most extensive and advanced tubercle with well-marked ulceration. In this case, also, the glands in the neck were considerably enlarged. On microscopic examination tubercle bacilli were found. In the large intestines, especially near the cæcum, there was regular honeycombing of the mucous membrane. There were numerous small crateriform ulcers in the lower part of the small intestine. There were also numerous opaque yellowish patches surrounded by slightly vascular areas; in many of these patches ulceration had fairly commenced.

PLATE VIII.

FIG. 17.

Small intestine of guinea-pig fed on raw grapes from Cow No. 31 (Part X., Table XCIII., p. 204). Animal died in 92 days after it was fed.

In this case the Peyer's patches were opaque, yellow, and non-vascular (*a*, a^1 and a^2), but in the surrounding intestinal wall there was marked congestion of the vessels, whilst those vessels near the surface of the mucous membrane, especially in the region of the opaque patches, stood out very prominently and may be seen in the photograph. The general congestion may also be seen in the dark areas of the two portions of the intestine to the right. Tubercle bacilli were found in this specimen.

FIG. 18.

Small intestine and cæcum of guinea-pig fed with 280 cc. of artificial tubercular milk Nos. 1, 2, 3, and 4, heated at 50° C. for two hours (Part XIII., Table CIII., p. 231). It was killed 172 days after the first feeding.

This animal was one of three, in all of which there was early tubercle. There were a number of tubercular patches in the cæcum (*a* and a^1) and large intestine, one or two of which were ulcerating. In the small intestine there were a few opaque points at the lower part (*b*), but ulceration was not at all a marked feature. Three large, firm, white, fibrous nodules were also found in the spleen, and there was well-marked tubercle in the liver. The mesenteric and mesocolic glands were greatly enlarged and hardened, especially those attached to the cæcum. In the lungs were numerous light grey nodules, but the glands at the root, though somewhat enlarged, were not distinctly tubercular. Tubercle bacilli were found on microscopic examination.

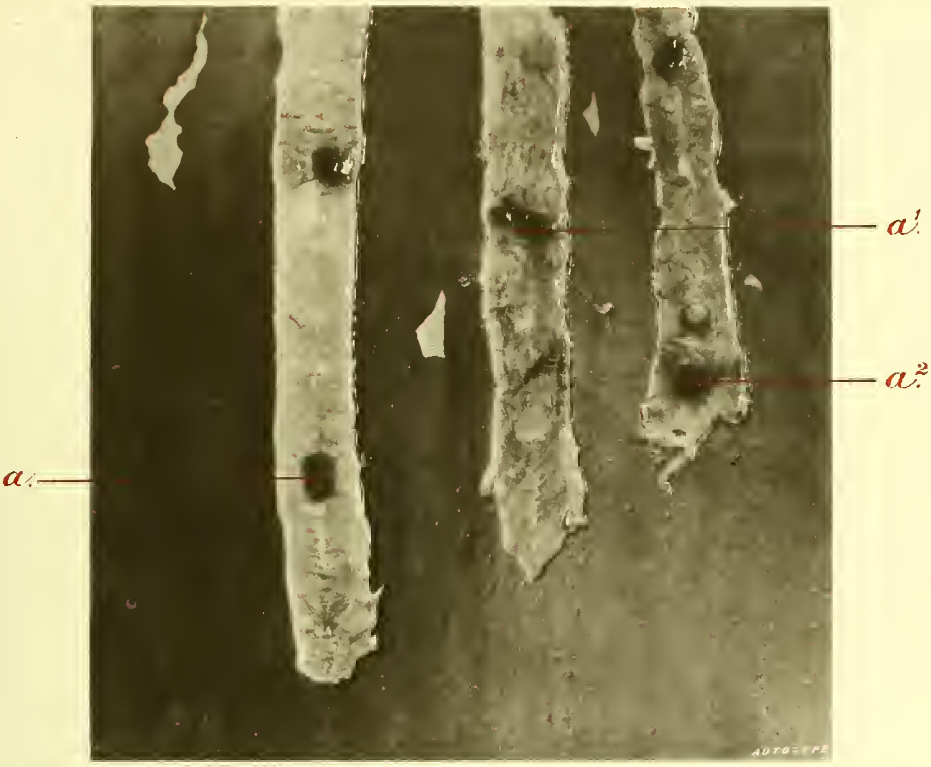


FIG. 17.

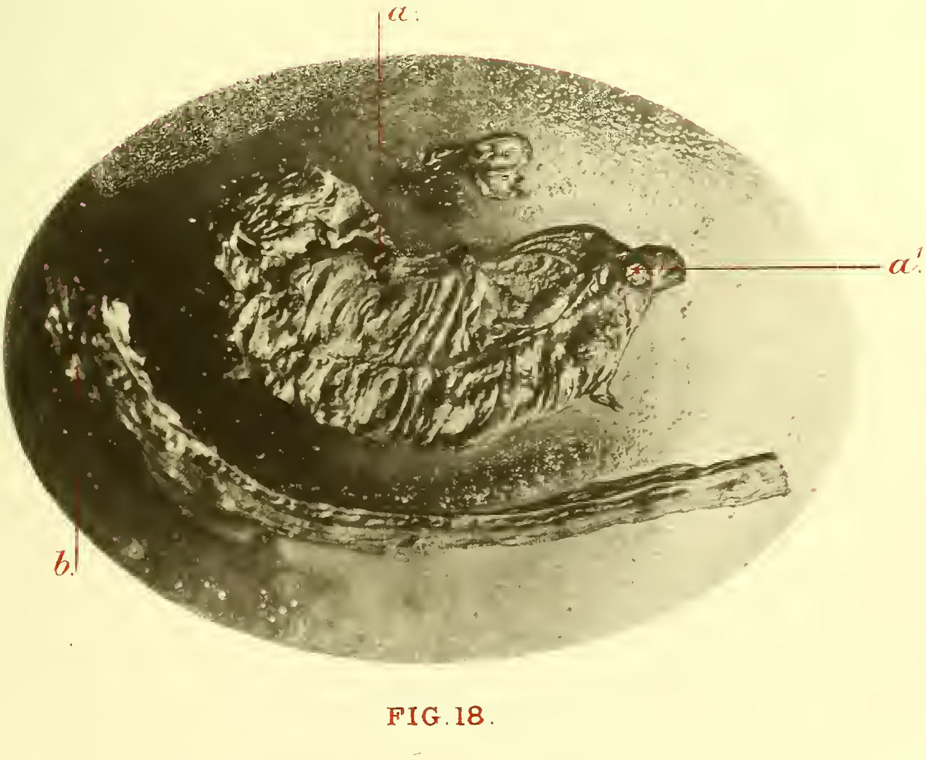


FIG. 18.

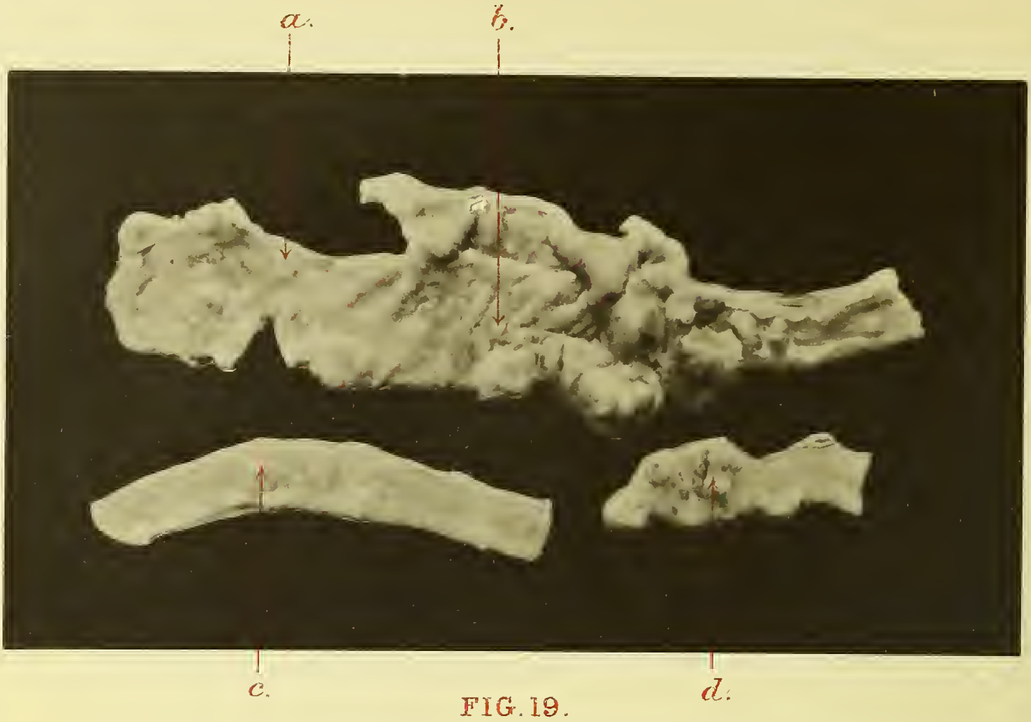


FIG. 19.

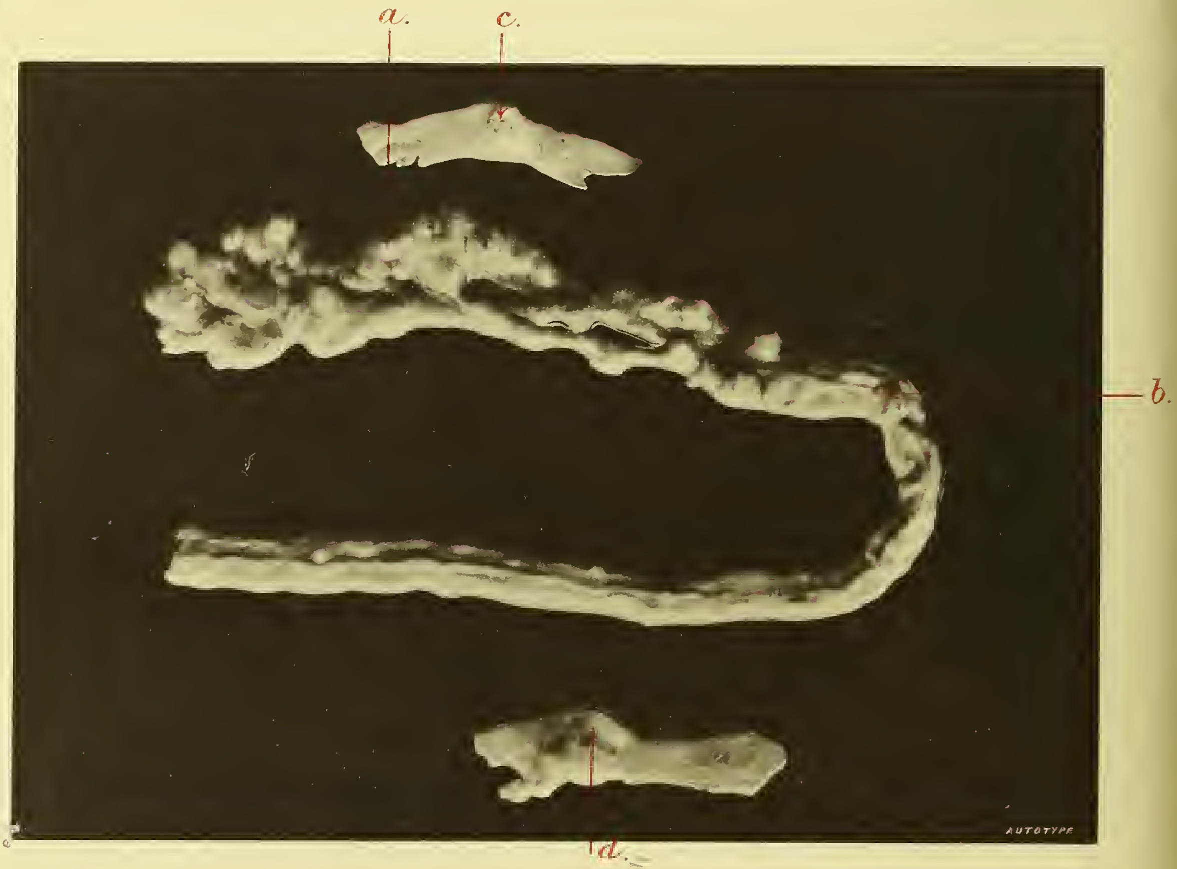


FIG. 20.

PLATE IX.

Fig. 19.

Large intestine, cæcum, and small intestine of guinea-pig twice fed with raw milk from Cow No. 25 (Part XII., Table CI., p. 226). Killed 119 days afterwards.

As will be seen from the photograph, the intestines, both large (*a* and *b*) and small (*c* and *d*), were extensively ulcerated. The mesenteric and mesocolic glands were greatly enlarged. There were numerous large tubercle nodules in the spleen and a number of fine tubercular points in the liver. There were similar minute points in the lungs, and the glands at the root of the lung and the anterior mediastinal glands were enlarged and tubercular. Tubercle bacilli were found in cover-glass preparations and sections made from the organs of this animal.

Fig. 20.

Guinea-pig fed with 25 cc. of raw artificial tubercular milk No. 9 (Part XIII., Table CVII., p. 264), and killed 56 days afterwards. The intestines (*a*, *b*, *c*, and *d*), as will be seen from the photograph, were distinctly tubercular and ulcerated. The tubercular patches were opaque and somewhat yellow, with slightly ulcerated points on the surface. The surrounding mucous membrane was somewhat congested. Tubercle bacilli were found on microscopic examination. The other lesions in this animal were enlargement of the glands under the jaw and in the neck, and adhesion of the lungs, which contained large masses of tubercle, to the chest wall; the post-sternal, mediastinal and bronchial glands were all tubercular and caseous: the spleen, liver and mesenteric glands were all markedly affected with tuberculosis, the latter being enormously enlarged.

PLATE X.

Fig. 21.

Section of small intestine of guinea-pig fed with boiled meat from Cow No. 16 (Part X., Table LXXXIV., p. 192), in which it was thought that there might be some tuberculosis of the solitary glands. On microscopic examination, however, it was found that the wall of the intestine, with the exception of increased cellular infiltration at one or two points, was absolutely normal. No tubercle bacilli could be found, nor was there any other evidence of tubercle. This section, therefore, may be taken as representing the appearance of the healthy mucous (*a*) and serous (*b*) membranes. (x. 70.)

Fig. 22.

Photograph of section of the small intestine at the margin of a very early tubercle nodule from guinea-pig fed with raw tuberculous lung of Cow No. 16 (Part X., Table LXXXIV., p. 193, the second animal of the set), in which there was noted, on naked-eye examination, very early tubercle in the intestine. To the right of the photograph the comparatively healthy villi supported on a delicate connective tissue papilla and covered with layers of cubical epithelium may be made out (*a*); whilst to the left (*b*) the marked cellular infiltration of the papillæ, so characteristic of the tubercular process, is very well brought out; this infiltration extends from the mucous down to the serous surface. (x. 100.)

Fig. 23.

Photograph of the intestine of one of the animals fed on raw tuberculous glands of Cow No. 21 (Part X., Table LXXXVII., p. 195). This animal was killed 26 days afterwards. There were well-marked lesions in the intestine, in the liver, and in the spleen. On examining the intestine a number of opaque, thickened, tubercular-looking patches were seen. Of these we have here a photograph, in which the great thickening of the mucous and sub-mucous tissue can be made out; this was due, apparently, to the accumulation of a considerable number of new cells. At the margins of the growth, the villi with their epithelial coverings are almost normal in appearance (*c*), but near the centre (*a*) it will be observed that they have undergone marked degenerative changes, that we have, in fact, a process of commencing ulceration. In the centre of the consolidated patch is a small caseous, degenerated area (*b*) which comes out black in the photographs. The serous membrane (*d*) is practically intact. (x. 25.)

Fig. 24.

Photograph of a piece of the centre of the same patch but magnified. Here the ulcerating surface is well seen to the right (*a*), to the left we have the remains of the epithelial covering. The new cell tissue (*b*), evidently with numerous lymph spaces but no vessels, is well seen. The dark caseous patch a little to the right of the centre (*c*) and the normal peritoneal covering (*d*) with wide lymph spaces beneath, are also well brought out. (x 100.)

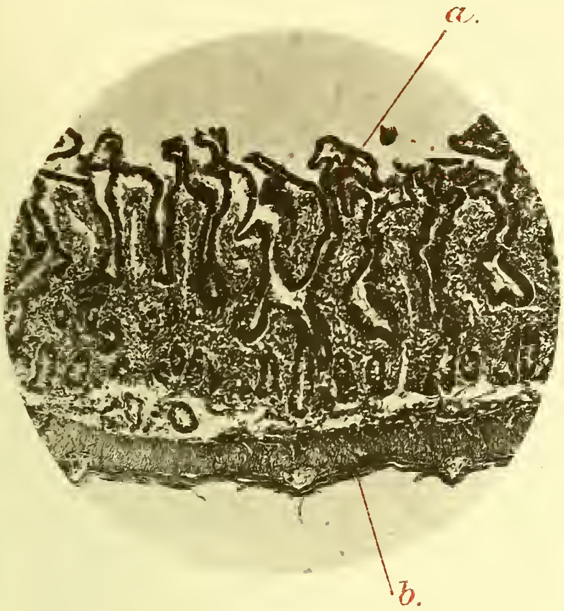


FIG. 21

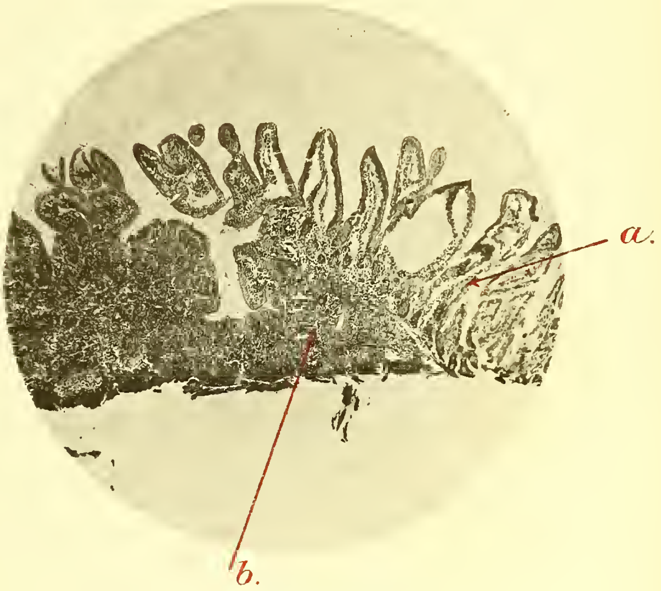


FIG. 22.

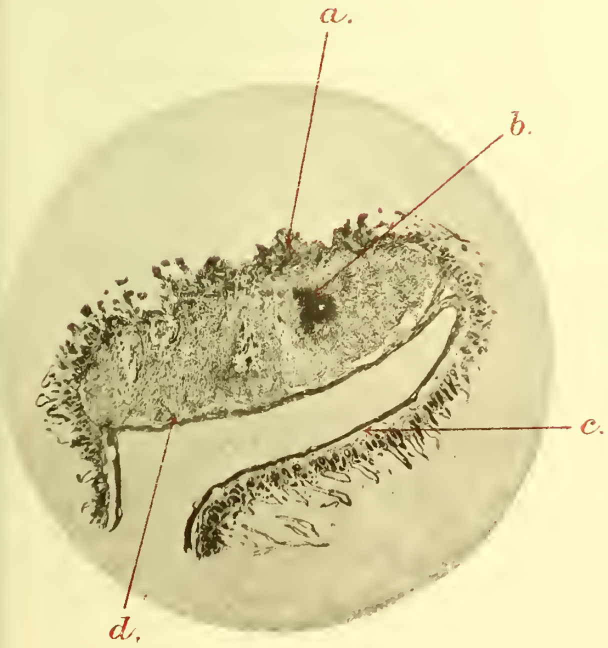


FIG. 23.

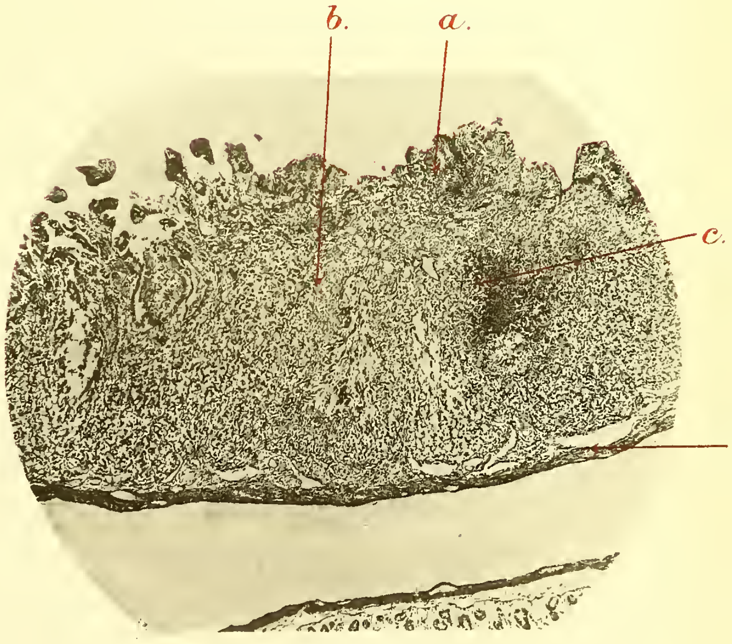
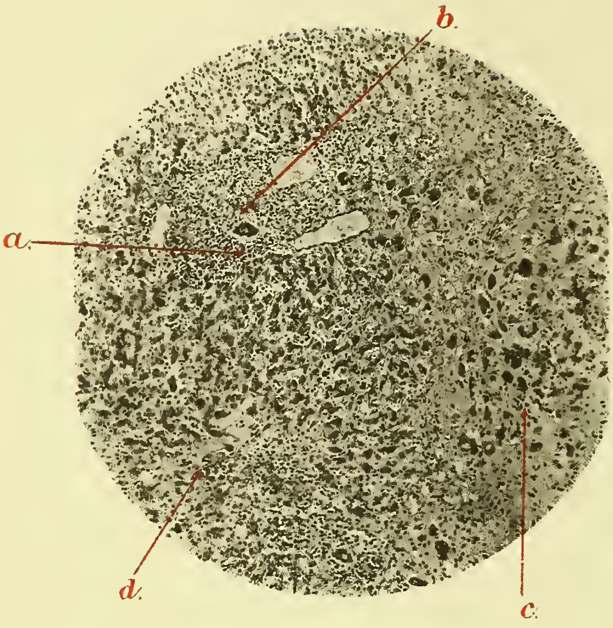


FIG. 24.



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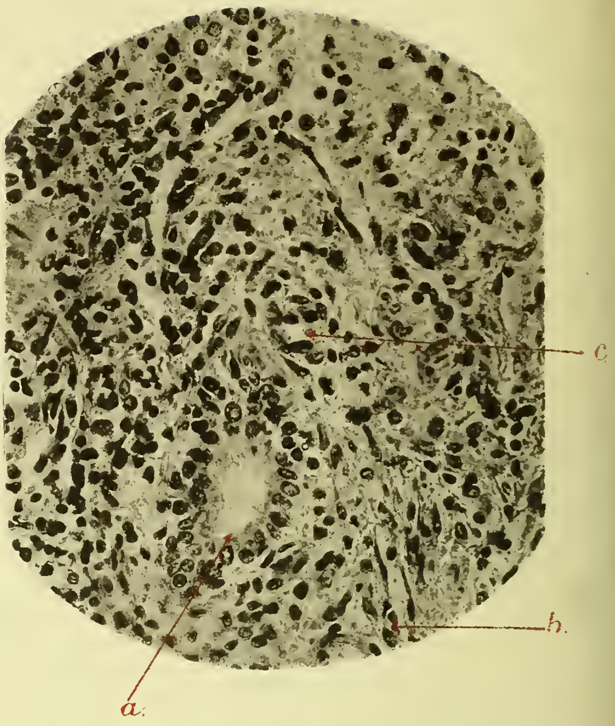

FIG. 26.

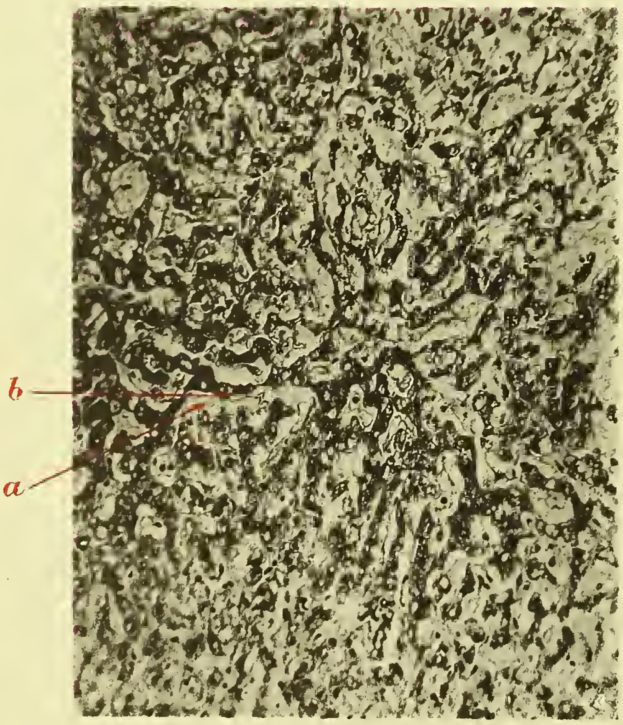

FIG. 27.

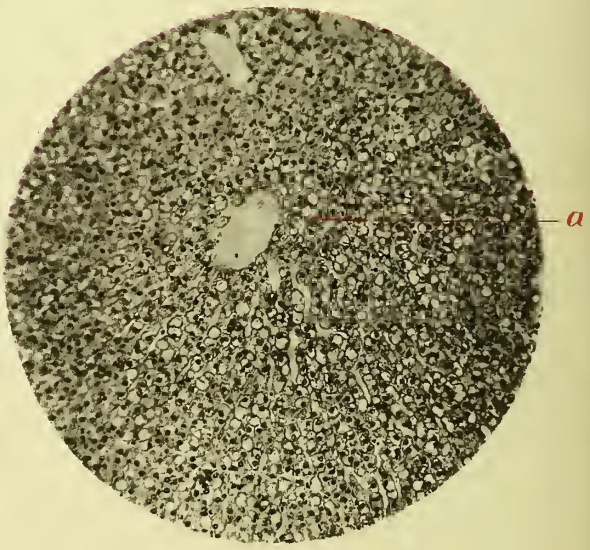

FIG. 28.

PLATE XI.

Fig. 25.

Cirrhotic liver of guinea-pig fed with Material No. 5 (Part XI., Table XCVIII., p. 220). This animal died 38 days after being fed, when no specific evidence of tuberculosis could be found. On examining the liver microscopically, however, it was evident that there was an increase of young cellular connective tissue around the bile-ducts, whilst between the columns of liver cells there was marked increase in the amount of connective tissue, the liver cells themselves were atrophied, the bands of connective tissue between them being wide and not very cellular. There was not the slightest trace of any tubercular process, though there must have been some irritative process going on to set up such a marked interstitial hepatitis as has here been developed :—

(*a*) Bile-duct;
(*b*) Small-celled infiltration in portal space;
(*c*) Clump of atrophied liver cells;
(*d*) Band of connective tissue. (x. 75.)

Fig. 26.

Section through one of the greyish white nodules found in the liver of a guinea-pig fed with Materials Nos. 8 and 9 heated to 75° C. (Table CVIII., Part XIII., p. 270), killed 104 days after the first feeding. The animal received 170 cc. in all. It is evident that in this case also there is an increase of fibrous tissue in the portal spaces, and it was thought before microscopic examination was resorted to, that these portal infiltrations might be due to the presence of tubercle bacilli. No tubercle bacilli could be found, but, as will be seen from the photograph, there is new formation of vascular connective granulation tissue around the bile-ducts in the portal spaces.

(*a*) Small bile-duct;
(*b*) Capillary vessel;
(*c*) Nucleus of connective tissue corpuscle. (x. 300.)

Fig. 27.

Photograph of a section made through a pale patch in the liver of a guinea-pig that came from Seven Dials, in which the naked-eye appearances might, on superficial examination, be mistaken for those of tuberculosis of the liver. On microscopic examination the greyish patches were found to consist of columns of atrophied liver cells (*a*) in which there was advanced fatty degeneration, whilst between these columns, the portal capillaries were of considerable size (*b*) and there was marked increase of the delicate connective tissue lying in the inter-columnar spaces. No evidence of tubercular structure could be found at any point in the liver. (x. 180.)

Fig. 28.

Liver from guinea-pig injected intraperitoneally with $\frac{3}{4}$ cc. of a mixture of 200 cc. of the serous fluid taken fresh from the most affected quarter of Cow No. 21 (Part XII., Table C., p. 225), plus 300 cc. of fresh milk, the whole heated at 70° C. for 10 minutes. The animal died in 31 days. The liver was pale and fatty looking; there was some congestion of the lungs, but no further evidence of tuberculosis. On microscopic examination the liver was found to be a most typical example of fatty infiltration, large globules of fat (*a*) distending the liver cells and pushing the nuclei to one side. (x. 80.)

PLATE XII.

Fig. 29.

Liver of guinea-pig which received an intraperitoneal injection of 2 cc. of an emulsion of a raw gland from Cow No. 11 (Part X., Table LXXX., p. 187.) This gland appeared somewhat softened but showed no evidence of any tubercular mischief. In the part photographed is a small interstitial mass of leucocytes (*b*) or connective tissue cells near a branch of the portal vein. To the naked eye this appeared almost like a minute tubercle nodule, but on careful microscopic examination no tubercle bacilli could be found, and there was no evidence of any hyaline or caseous degeneration of the new cells. There is slight fatty infiltration of some of the liver cells in the immediate neighbourhood of the portal spaces. (x. 85.)

Fig. 30.

Section of a liver from a guinea-pig fed with 80 cc. of Material No. 8 (Part XIII., Table CIX., p. 274.) This material had been heated to 80° C. and the animal was killed 98 days after the first feeding. A small, round, grey nodule was seen in the liver and it was thought that this might be tubercular. On microscopic examination, however, it was found that near the surface was a small abscess which at *b* had begun to soften, whilst in the immediate neighbourhood there was a considerable small round-celled infiltration (*c*). In this area of small round-celled infiltration the liver cells appeared to be undergoing degenerative changes, whilst immediately around they were in a condition of cloudy swelling. (x. 60.)

Fig. 31.

Fig. 31 is a low-power photograph of the section from which fig. 26 was photographed under a higher magnification. The bile-ducts (*a*), the new connective tissue formation, and the small round-celled infiltration (*b*) are here exceedingly well brought out. We have practically a condition of interstitial cirrhosis following a somewhat acute hepatitis. (x. 60.)

Fig. 32.

Another section from the liver represented in Fig. 29, which shows a similar patch of young cells (*a*) near the point of junction of two of the small portal vessels. Here again no tubercle bacilli could be found; we have simply a slight localised interstitial hepatitis, such as appears to be the sequel of ingestion of irritant matters and their absorption along the lines of the portal veins. These specimens were photographed because they may resemble, both naked eye and microscopically, minute tubercle nodules in the liver. (x. 180.)

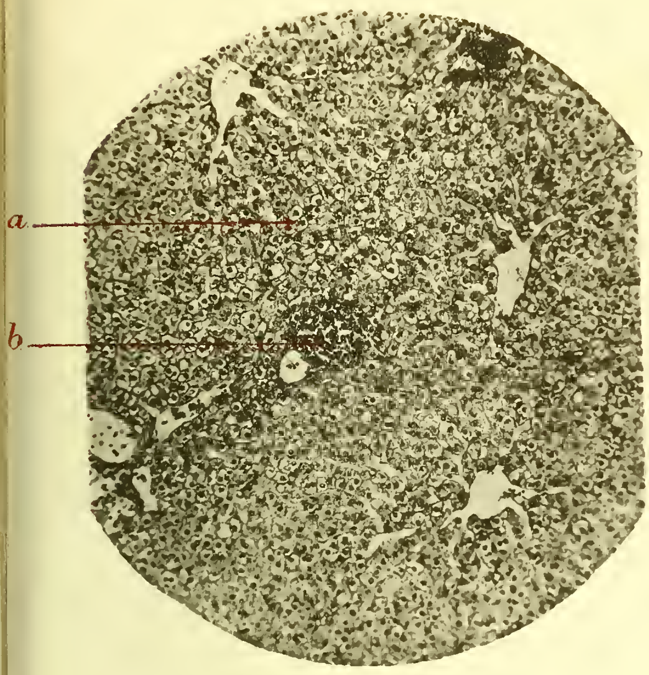

FIG. 29.

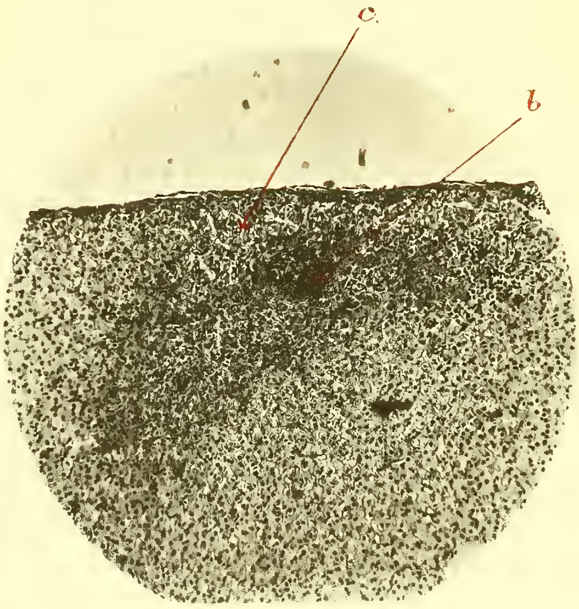

FIG 30.

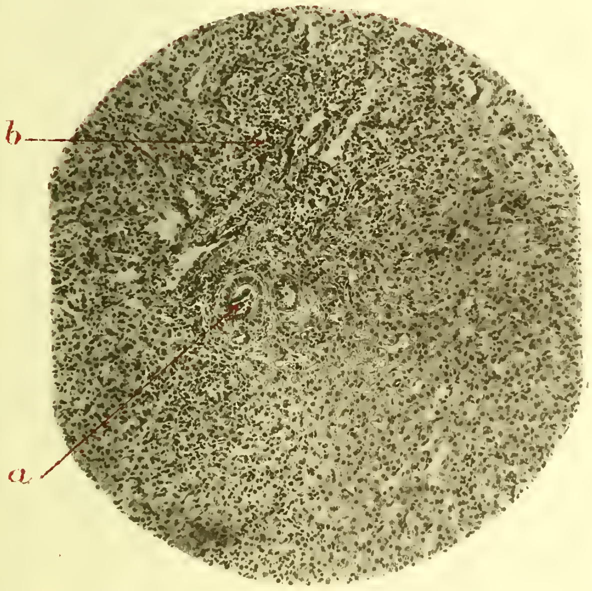

FIG 31.

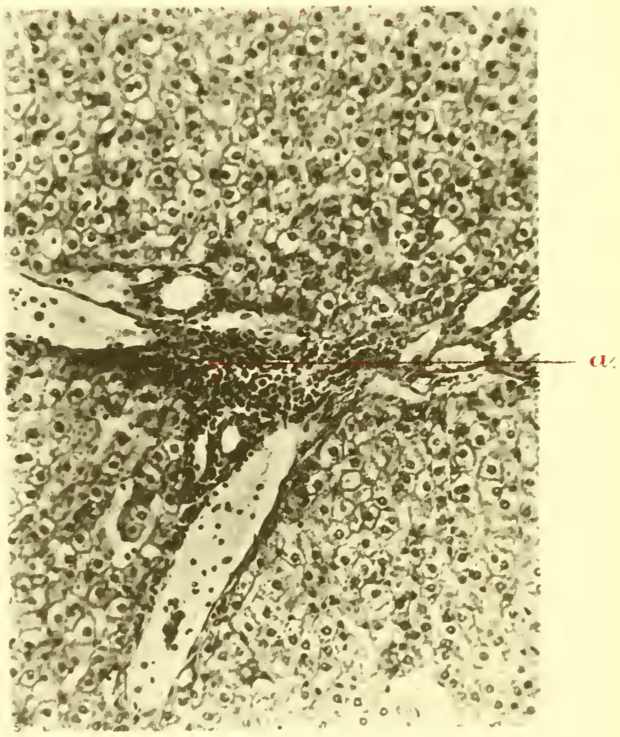

FIG. 32.

(*To face page* 293.)

INQUIRY III.

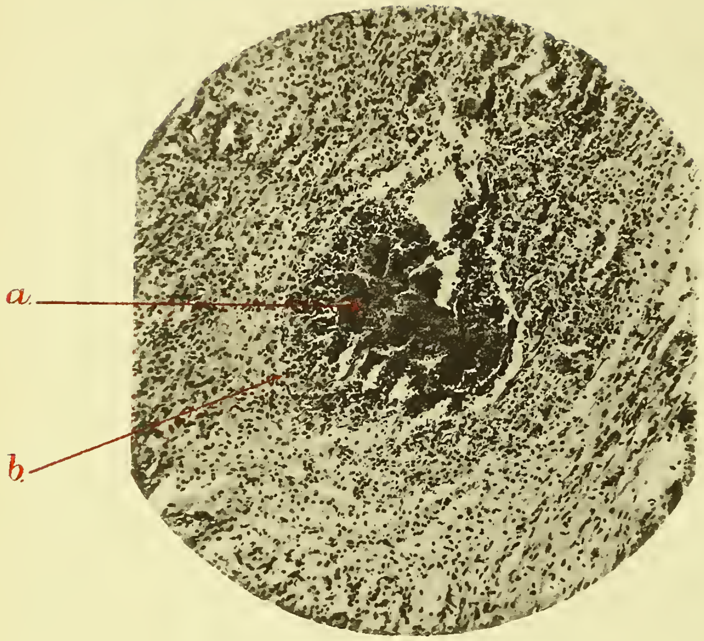

FIG. 33.

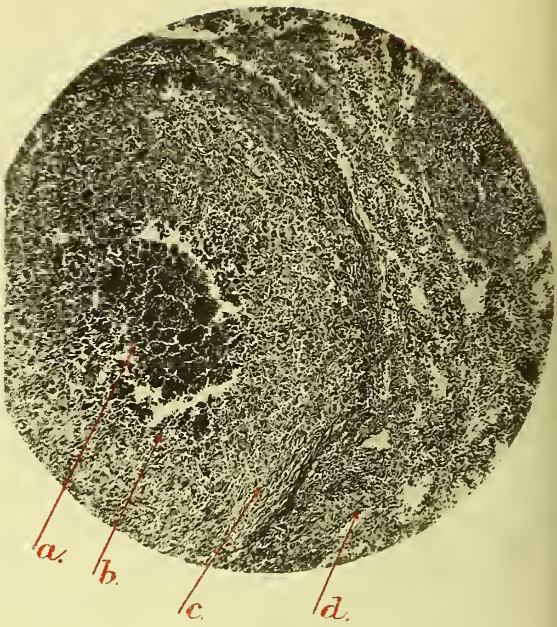

FIG. 34.

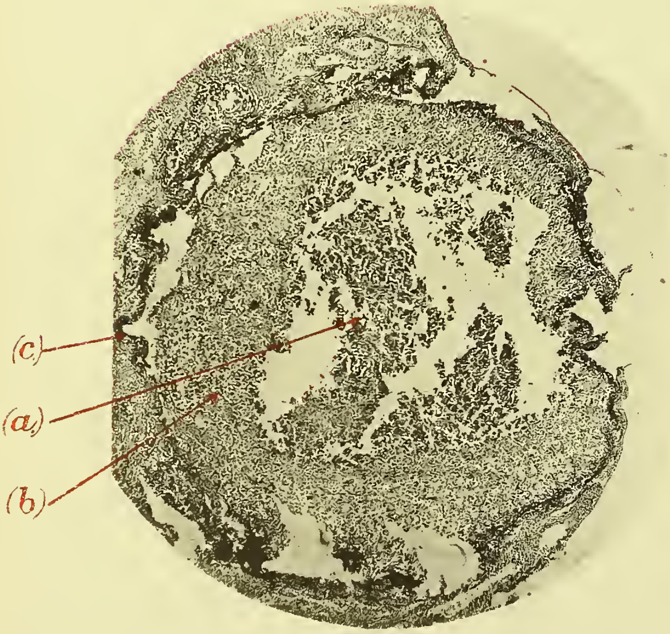

FIG. 35.

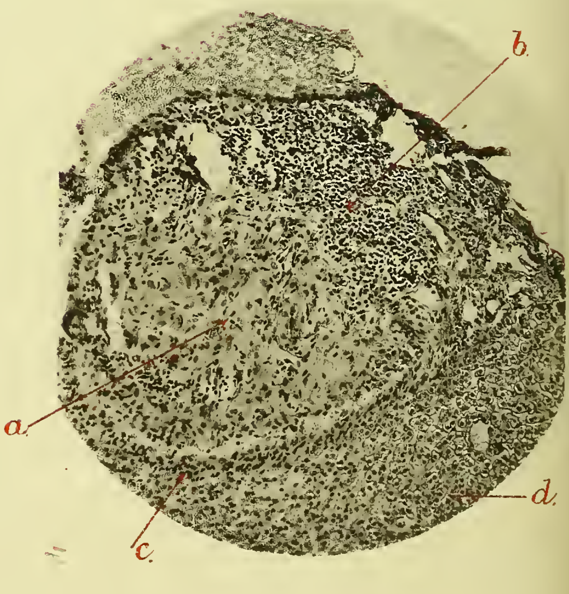

FIG. 36.

PLATE XIII.

Fig. 33.

Section through the small intestine of a guinea-pig injected with 6½ cc. of artificial tubercular milk, 5*a* and 6 (Part XIII., Table CVII., p. 269), heated at 70° C. for one hour. This animal died 11 days after the injection, when it was found that there had been peritonitis and adhesion between the visceral and parietal serous membranes. At one or two points there were several large adenoid patches with small opaque areas in the mucous membrane of the intestine over the adherent surfaces. On examination of some of of these swollen patches, the appearances represented in this figure were observed. The opaque patch consisted of tissue in an advanced stage of necrosis (*a*), whilst surrounding this dead mass numerous leucocytes (*b*) and micro-organisms were found. These micro-organisms were in the form of short bacilli, some of them appearing almost like diplococci, as the ends were so much more distinctly stained than the central portion. This was evidently a necrosis due to the action of some organism other than the tubercle bacillus. (x. 80.)

Fig. 34.

Photograph of a small nodule of the spleen of guinea-pig that had been inoculated with a piece of the buttock, roasted 2½ hours, from Cow No. 15 (Table LXXXIII., Part X., p. 190). The animal was killed 49 days after the inoculation, when it was found that the wound had not quite healed. All the organs except the spleen were perfectly normal, but in the spleen were several nodules which to the naked eye looked exceedingly like small infarctions. On section these nodules were found to consist of three layers: One (*a*) necrotic area in which the cells were dead and had become fused into irregular masses; in it were a number of short bacilli similar to those present in the necrosed area of the intestine represented in Fig. 33, but no tubercle bacilli could be made out. Around this was a zone (*c*) of connective tissue and leucocytes, with (*b*) shadowy-looking splenic tissue between. (x. 75.) (*d*) Normal spleenic tissues. This is evidently another case of pseudo tuberculosis, a condition several times met with in animals injected with emulsions of meat or glands, both cooked and in the raw condition. It is not a tubercular lesion, but, unless very carefully examined, may readily be mistaken for one.

Fig. 35.

Fig. 35 represents a very similar condition of the spleen, in which, however, the central degenerating area (*a*) is larger and the line of demarcation between the necrotic area (*b*) and the surrounding tissue (*c*), though distinctly seen, is not in the form of such a prominent fibrous capsule. The guinea-pig from which this spleen was taken had also been inoculated with raw meat taken from the ribs of Cow No. 15 (Table LXXXIII., Part X., p. 190). The inoculation wound was quite healed. The spleen presented the same nodular infarcted appearance; the other organs were quite normal. (x. 80.)

Fig. 36.

Photograph of a section through a small yellow nodule about the size of a millet seed, which was found near the surface of the liver of a guinea-pig that had been injected with 1½ cc. of artificial tubercular milk No. 10 (Part XIII., Table CVII., p. 267), which had been heated to 70° C. for ten minutes. The animal was killed 101 days after the inoculation. On microscopic examination this small nodule was found to be made up of a little mass of organising connective tissue (*a*) in which were running a number of small blood vessels. At one side of the mass, and near the surface of the liver, were numerous leucocytes (*b*) and young connective tissue cells in which the blood channels were larger and more numerous than were those in the older fibrous nodule. Immediately under the capsule there was a distinct line of demarcation (*c*) between this mass of cellular tissue and the surrounding liver substance (*d*). Not a single tubercle bacillus could be found on the most careful examination, and we were compelled to come to the conclusion that this growth was not of tubercular origin. (x. 70.)

PLATE XIV.

Fig. 37.

Photograph of section of tubercle of the lung of a pig fed with raw meat from Cow 21 (Part X., Table LXXXVII., p. 195); this pig was killed 72 days after the feeding. The glands at the root of the lung were not enlarged, but in the lung itself there was a small caseous mass suspiciously like a tubercle nodule. To the left of the section (*a*) is normal lung tissue, to the right is an area in which there was evidence of a caseous broncho-pneumonic process. In the lower part is a regular tubercle follicle (*c*), caseating in the centre, with reticular adenoid tissue around. Tubercle bacilli were demonstrated in this specimen. (x. 80.)

Figs. 38 and 39.

Figs. 38 (x. 80) and 39 (x. 180) are photographs from the lung of a guinea-pig injected intraperitoneally with 5 cc. of the unsterilised milk from the front left teat of an emaciated cow in which no trace of tuberculosis could be found. At one or two points in the lung there was some peribronchitis and slight perivascular infiltration, and, as represented in Fig. 39, a section through one of the blood vessels (*b*) and its surrounding lymphatics disclosed the presence of a small cellular nodule (*c*). In this nodule, however, it was impossible to distinguish any degenerative hyaline or caseating change in any part; nor could tubercle bacilli be found after the most careful search. There was evidently no extension of the process from this one point, and the lesion cannot be looked upon as in any sense of tubercular origin.

(*a*) Normal lung or lung with slight catarrhal changes only.

(*b*) Lumen of blood vessel.

(*c*) Perivascular small celled growth or infiltration.

Fig. 40.

Tubercle bacilli photographed from a cover-glass preparation of the fluid squeezed from a tubercular nodule of the spleen of a guinea-pig injected with artificial tubercular milk, Nos. 1 and 2 (Table CIV., Part XIII., p. 240), heated at 60° C. for 45 minutes. In this case there was early tubercle of the spleen, pancreas, and mesenteric glands, and more advanced disease in the deep inguinal and cœliac glands; the post-sternal glands were also affected, but the other organs were normal. It will be seen that tubercle bacilli were present in considerable numbers. (x. 1,000.)

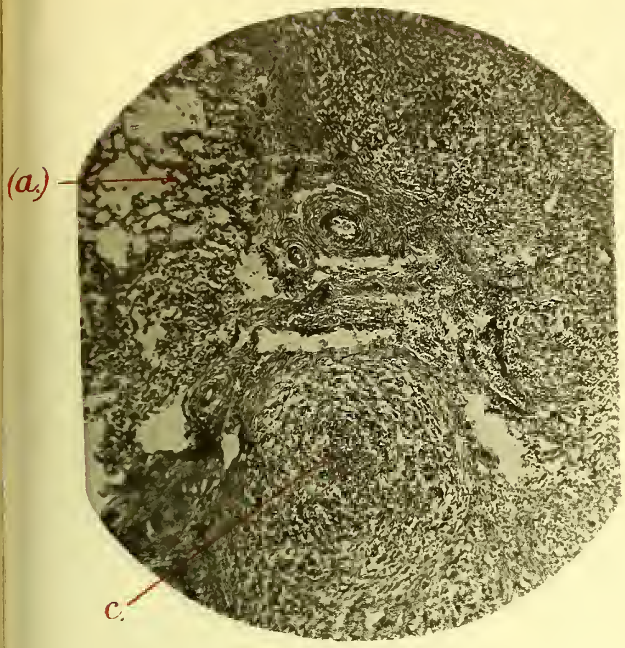

FIG. 37.

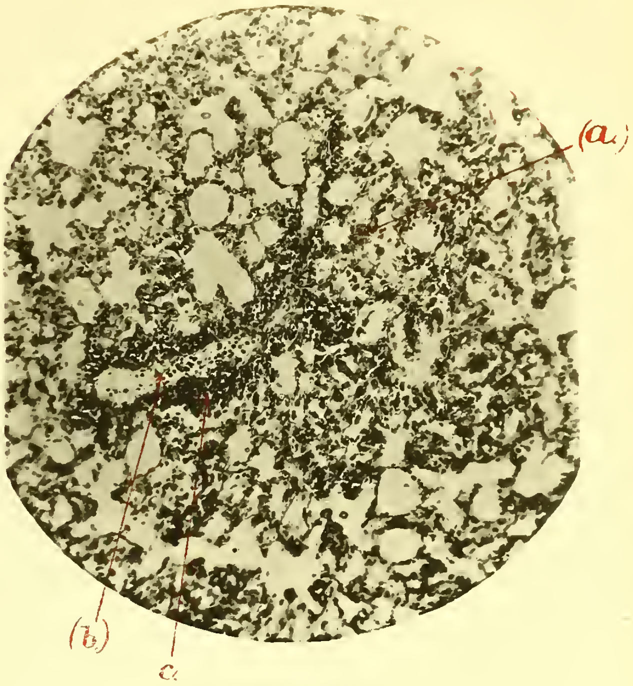

FIG. 38.

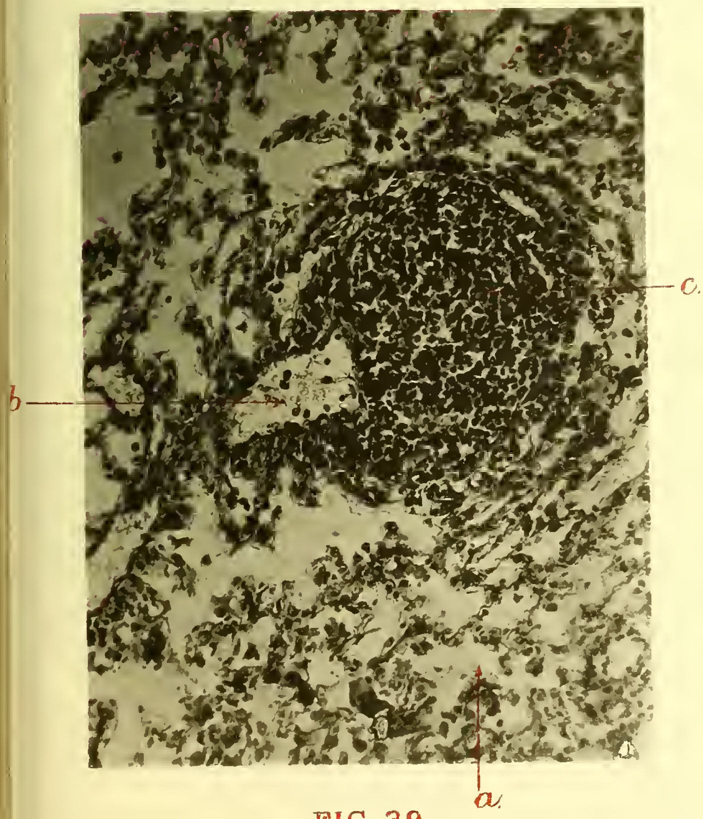

FIG. 39.

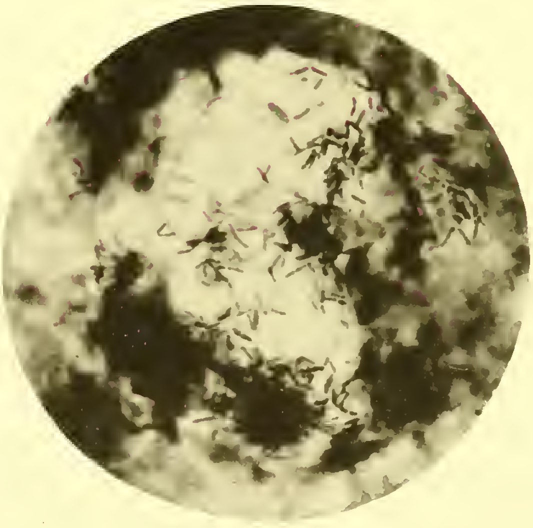

FIG. 40.

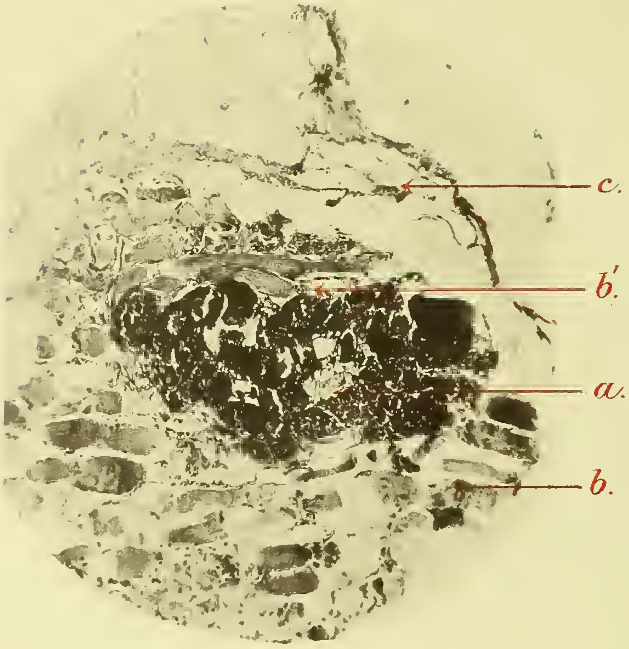

FIG. 41.

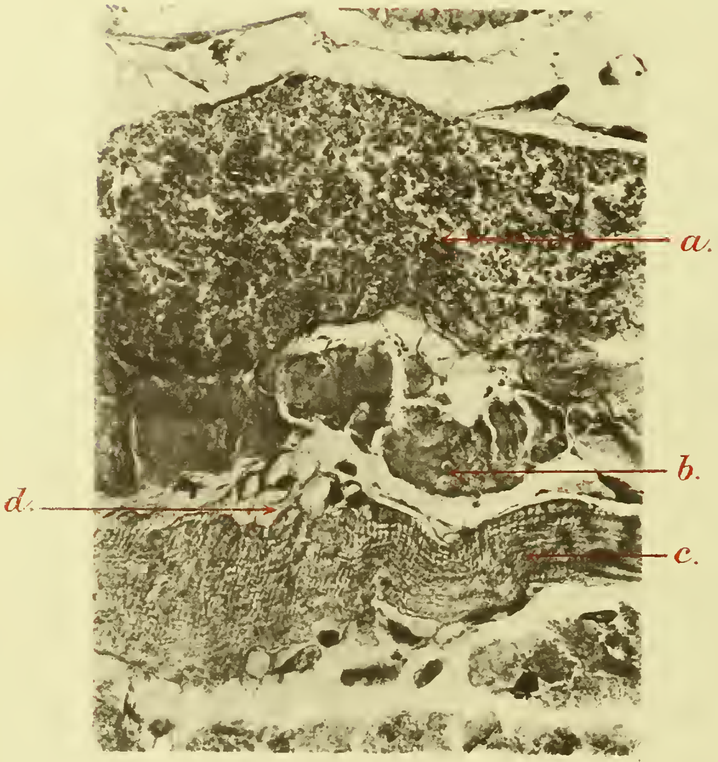

FIG. 42.

PLATE XV.

Fig. 41.

Low-power photograph of one of the small grey areas in the muscles of Cow No. 12 (Part I., p. 113), which simulated grey miliary tubercular granulations. It will at once be seen that the muscle fibres are swollen and have undergone a hyaline or vitreous degeneration, the degenerated mass being fragmented apparently through traction by the healthy muscle. It will be noted, too, that in the immediate neighbourhood of the hyaline patch there is a slight increase in the number of leucocytes in the connective tissue cells; this becomes more marked after a time, and we have the formation of a fibrous tissue capsule around the degenerating area. In this specimen *a* indicates the degenerating muscle, *b* and b^1 normal muscle fibres, *c* areolar connective tissue. (x. 80.)

Fig 42.

In Fig. 42, in which the magnification is very much higher, the difference in appearance between the degenerated muscle (*a*), which has undergone a granular disintegration after the occurrence of the great swelling of the fibre; *b*, of the fibre which, though not yet breaking down, has lost its transverse striation; and *d*, normal muscle fibre, in which the striation is still distinctly marked, is well seen. At *c* are nuclei of connective tissue and adipose cells. (x. 400.)

PLATE XVI.

Fig. 43.

Drawing of a group of opaque tubercle nodules, situated near the lower end of the small intestine of a guinea-pig fed once with raw grapes from the ribs of Cow No. 31 (Part X., Table XCIII., p. 204). The animal died 45 days after. The tubercle nodules of this group were opaque, yellowish, and one or two of them (*a*) were slightly depressed in the centre. The mucous membrane in the immediate neighbourhood was somewhat flushed, and a number of distended vessels (*b*) could be seen running at right angles to the long axis of the intestine and in between the tubercle nodules. In this animal the mesenteric and cœcal glands were enlarged, cheesy, or in some cases gelatinous looking; they were evidently tubercular.

(To face page 296.)

INQUIRY III.

PLATE XVI.

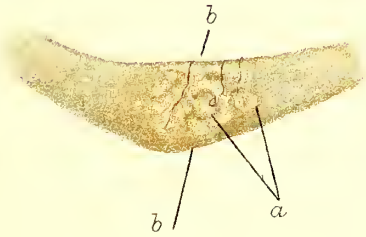

Fig. 43.

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Plate XVII.

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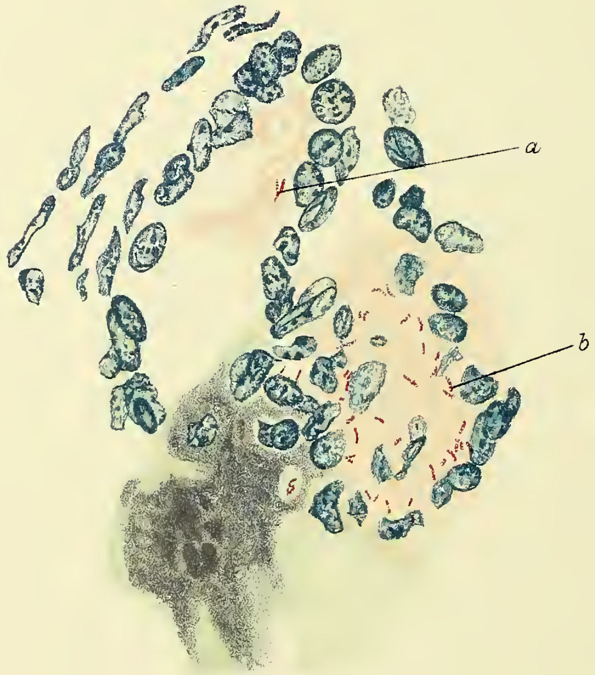

Fig. 44.

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PLATE XVII.

Fig. 44.

Section through the margin of a tubercular nodule in the udder of Cow No. 21 (Part X., Table LXXXVII., p. 195), left anterior quarter. The nuclei of the epithelial cells lining the ducts are somewhat irregular, and the cells are evidently undergoing degenerative changes, whilst in the lumen we have a peculiar hyaline mass in which are embedded (*a*) a couple of bacilli in one duct, (*b*) a large number of tubercle bacilli in the neighbouring duct. (x. 700.)

PLATE XVIII.

Fig. 45.

Section of tubercular udder from Cow No. 32 (Part X., Table XCIV., p. 205) slaughtered at Camden Town, the udder of which is now at the museum of the Royal Veterinary College. This section was made through a part of the udder in which the tubercular process was well advanced. The nuclei still stain distinctly, but between them there is a homogeneous looking mass in which tubercle bacilli are scattered in considerable numbers. Some of the nuclei in this specimen are evidently disintegrating and undergoing degenerative and atrophic changes, whilst at one or two points the bacilli appear to be actually within the degenerating cells. (x. 700.)

(To face page 298.)

INQUIRY III.

PLATE XVIII.

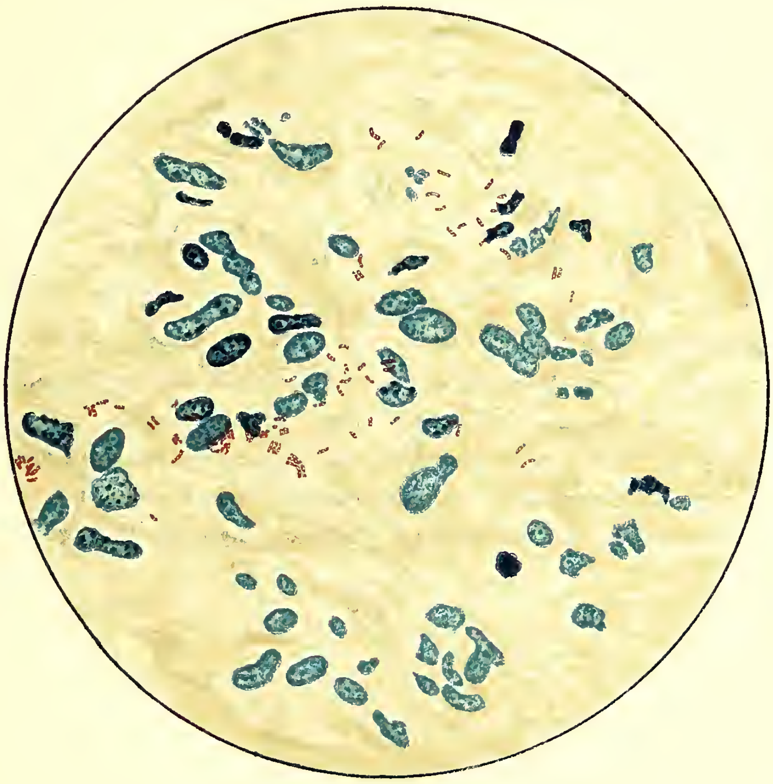

Fig. 45.

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INQUIRY III.

PLATE XIX.

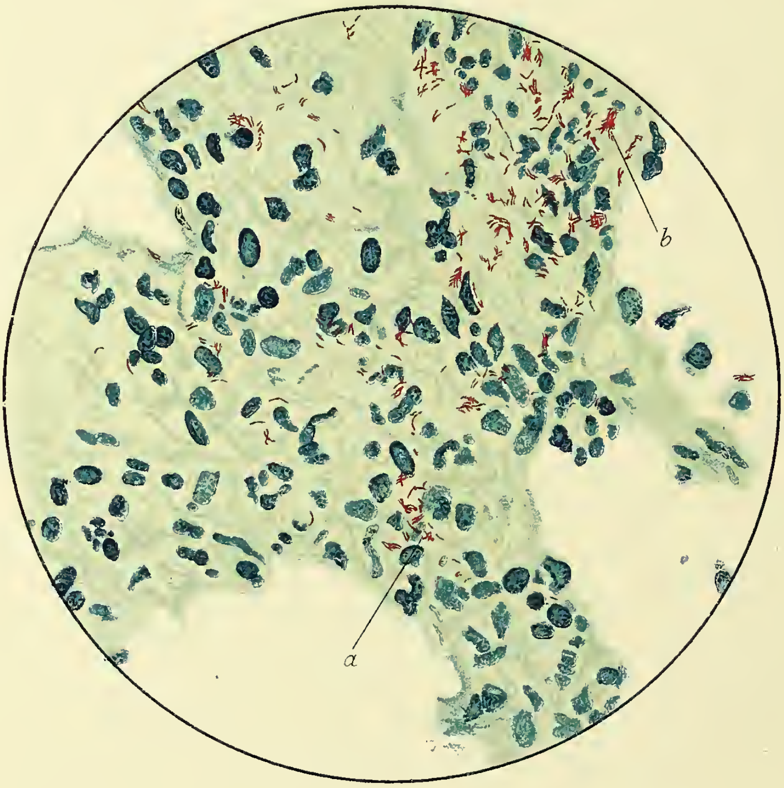

Fig. 46.

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PLATE XIX.

Fig. 46.

Section of lung of kitten fed with artificial tubercular milk No. 5 (Part XIII., Table CIII., p. 231). In this case the thickening of the interalveolar septa (*a*) and the tubercular catarrhal process (*b*) were well marked. The tubercle bacilli were present in considerable numbers in the breaking-down epithelial cells and also around the inter-alveolar capillary vessels. The animal received 100 cc. of the material and was fed with a spoon, and it is probable that infection was due to inhalation of some of the fluid which should have been swallowed, as both the lungs and the posterior mediastinal and bronchial glands were tubercular, but there was no tubercle of the intestine or of any of the abdominal organs. This animal was kept in a cage in the open air, and there was no possibility of infection from any other accidental source. (x. 700.)

PLATE XX.

Fig. 47.

Section through the mucous membrane of one of the roughened warty-looking growths of the stomach of the pig represented in fig. 10, Plate V. Near the surface is a dense felted network of bacteria, similar to those described by Bang, Hamilton, McFadyean and others. The tissue between has undergone a kind of hyaline necrotic change, and contains no traces of nuclei. The epitheleium has been cast off and the surface appears to be crumbling away. There is no evidence that this is in any way tubercular. (x. 700.)

(*To face page* 300.)

INQUIRY III.

PLATE XX.

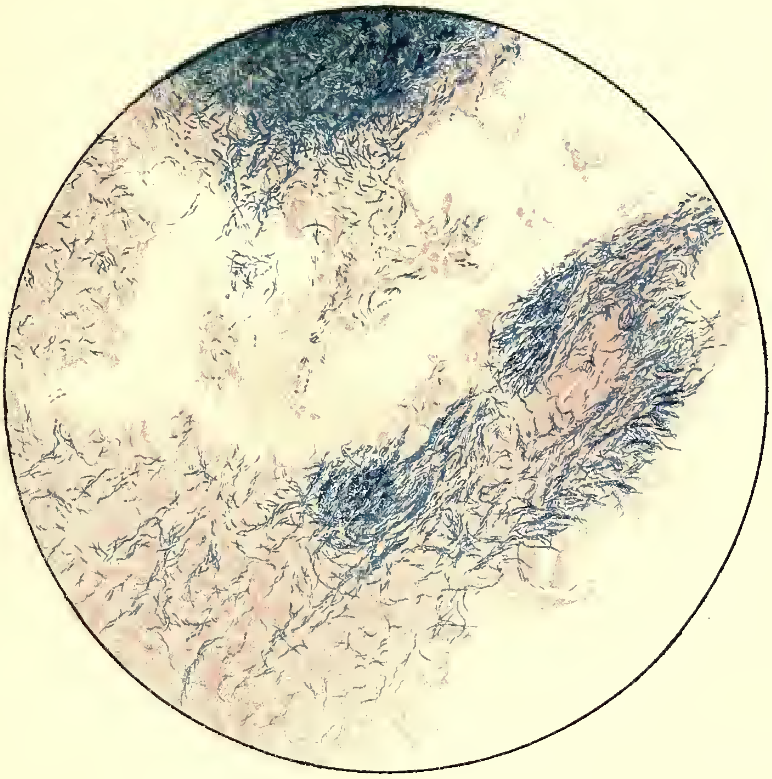

Fig. 47.

G. T. G.

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Plate XXI.

FIGURE 48.

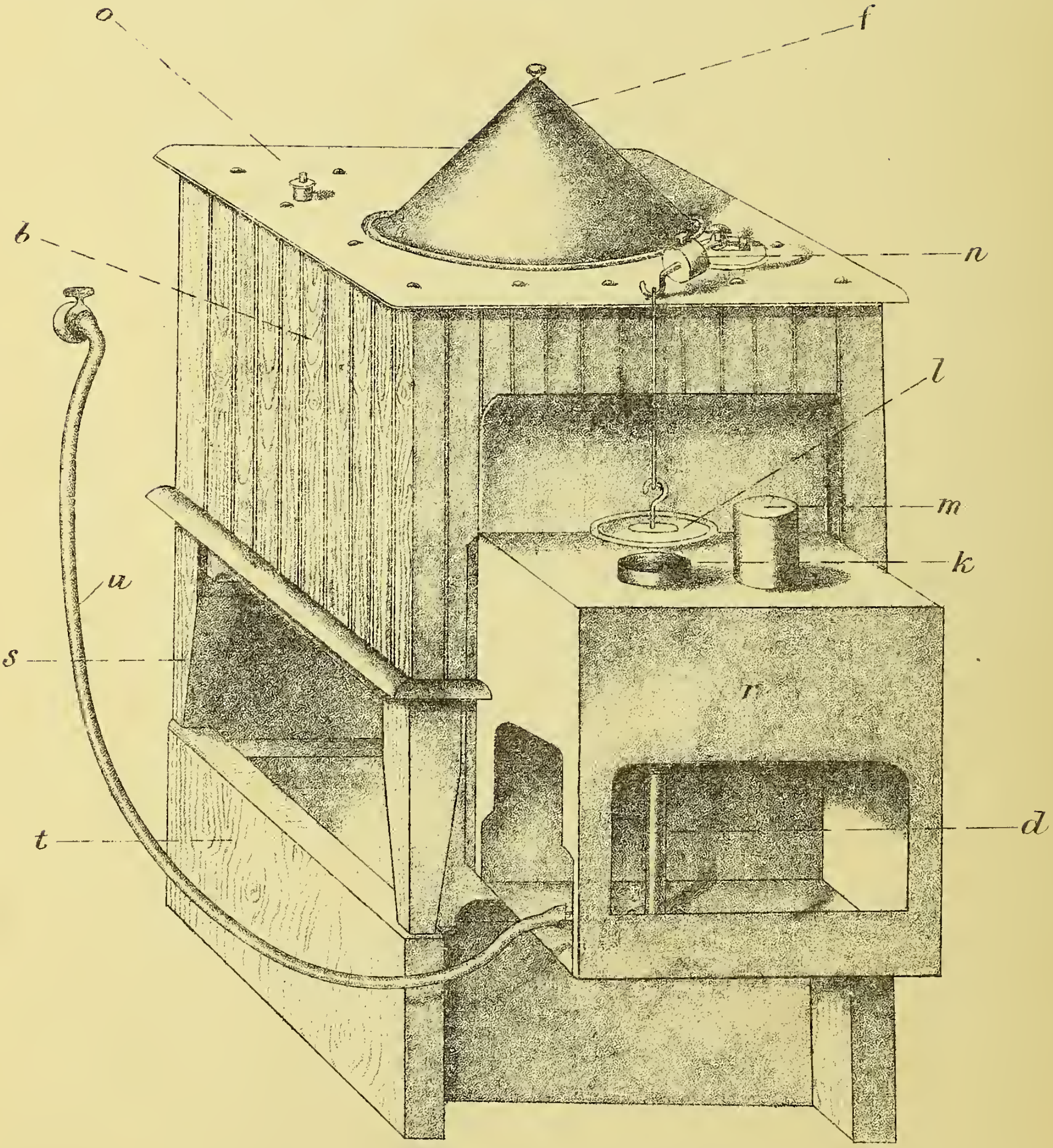

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PLATE XXI.

Fig. 48.

Sketch of Sterilising Apparatus.

b. Match-wood casing of outer bath.

d. Bunsen burner for heating water.

k. Flue through which heated air can escape directly without passing through "U" tube when damper (*l*) is raised.

m. Flue through which heated air escapes after passing through "U" tube, *see* Fig. 49.

n. Regulating weight which slides on lever of regulating valve.

o. Upper end of thermometer by which temperature in the outer bath is recorded.

r. Box filled with packing in which flues are embedded.

s. Wooden supports of steriliser.

t. Rough wooden stand to raise steriliser from floor.

u. Gas supply.

PLATE XXII.

Fig. 49.

Drawing of Section of Sterilising Apparatus.

a. Copper wall of outer water bath encased in match-wood covering (*b*).

c. "U" tube along which heat from Bunsen flame is conducted when valve (*l*) is closed, which makes flue (*k*) into a chamber open only where Bunsen flame rises, and at (*c*) one limb of "U" tube which unites with the other limb by the bend at (*m*).

d. Bunsen burner supplying heat.

e. Copper cylinder forming the inner water bath in which the milk is sterilised.

f. Conical double copper lid.

g. Lever hinged at one end and resting on a vertical rod (*h*), which rests in a small cup on the regulating capsule (*i*) immersed in water.

n. Sliding regulating weight with pinching screw to fix it in position on the bar.

o. Thermometer.

p. Overflow pipe.

q. Tap for drawing off water.

r. Hot air chamber packed with asbestos.

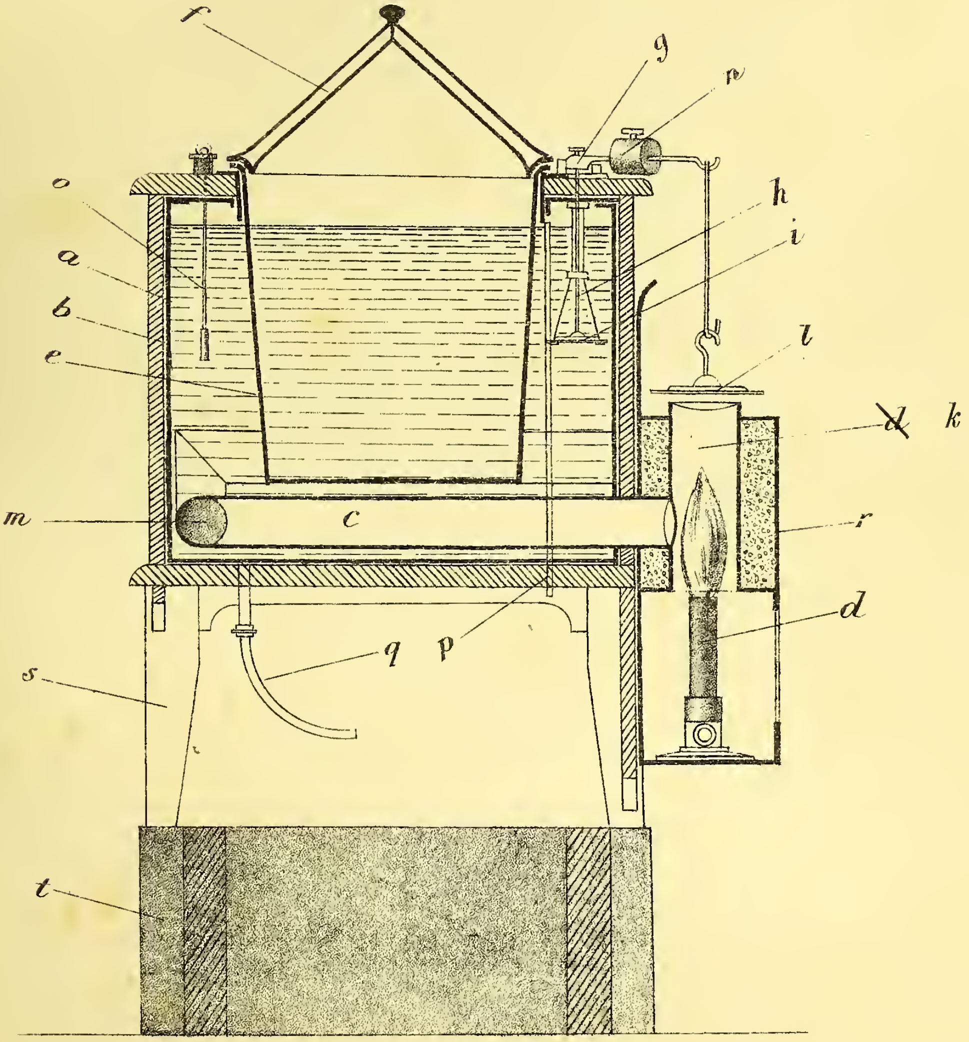
s. Wooden supports of steriliser.

t. Rough wooden stand to raise steriliser from floor.

(*To face page* 302.) INQUIRY III.

Plate XXII.

FIGURE 49.



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